CASE STUDY IN MODELING ACCESSIBILITY FOR ONLINE INSTRUCTION

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By

Thomas Hayes Conway

Dissertation Committee:

Michael Menchaca, Chairperson

Ellen Hoffman

Peter Leong

Seungoh Paek

Luz Quiroga

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ABSTRACT

The purpose of this qualitative multiple case study was to explore how accessibility standards are adapted to create online learning environments that are accessible to people who use assistive technology, or have navigational challenges due to physical or intellectual disabilities. Rogers diffusion of innovation was used as the contextual framework with the focus on the re-invention step occurring during the implementation stage of Rogers theory. Four participants of a research project dedicated to training people with disabilities for employment using online learning modules, live video chat mentoring sessions, and a multiple user virtual environment, were interviewed. Theme development resulted in a preference for multiple means of representation related to Universal Design for Learning and the need for confidence building through technology use.

The findings of this research study recommend implementing a more inclusive online community where people who use assistive and accessible technologies can engage and interact through web-based communication platforms and equally participate in socially relevant activities such as education and employment.

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CHAPTER 1. INTRODUCTION

This research study uses multiple-case studies with each participant having a different and unique disability, to better understand how accessibility guidelines are used to develop an online curriculum for people with disabilities. Using unpublished, existing data from the *EmployAble* project, specifically data from pre and post surveys, along with four semi-structured, open ended interviews of the project participants, theme development relating to the research questions of how accessibility was built into the project will be analyzed.

Statement of the Problem

If people with disabilities are to be included in emerging technologies widely used by the general public, and benefit from the opportunities provided by that access, then a better understanding of how they interact with the web needs to be examined. Creating accessible content and delivery, as defined by Section 504 of the Rehabilitation Act of 1973 (29 U.S.C.A. § 701 et seq.) and Section 508 of the Technology Act (29 U.S.C. § 794d), requires that all electronically-delivered content be made accessible to a wide range of end users. This includes individuals who use assistive technology devices for accessing information via publicly available communication modes (e.g., telephone, television, and the Internet). Although these laws have been in place and updated periodically (Kanayama, 2003), enforcement has been limited (Goldberg, 2013).

Purpose

The purpose of this research proposal is to explore how accessibility standards are adapted to create online learning environments that are accessible to people who use assistive technology, or have navigational challenges due to physical or intellectual disabilities. Although accessibility guidelines and laws have been created for the purpose of universal access to the World Wide Web, its inventor, Sir Tim Berners-Lee, among others, question whether such a goal has been realized (Farrelly, 2011; Bühler, Engelen & Kemppainen, 2011; Foley & Ferri, 2012). Twenty five years after the development of web accessibility guidelines (Kelly, et al., 2007; Kelly, et al., 2009; Friedmeyer-Trainor, Vernon, & Lynch, 2012), full access to the web by people who use assistive technology has still not been achieved.

The challenge for this research project is how technical accessibility is modeled for a universally designed online learning experience. The multiple-case study is based on a two-year pilot project funded by the Kessler Foundation (www.cds.hawaii.edu/employable) called *EmployAble: A World Without Barriers*. This pilot project used online technology to teach employment skills to people with disabilities, using a combination of tools including a web-based, self-paced learning module, peer-mentored online group sessions, and a Multi User Virtual Environment (MUVE) created in Second Life® to simulate 3-D modeled businesses. *EmployAble* was the first documented research project to attempt to deliver comprehensive employment training online with a multi-user virtual environment and across a diverse participant population of disabilities and geographical locations (www.kesslerfoundation.org).

Research Questions

To address the purpose of this study, the following research questions were explored:

1. How did users with disabilities perceive the integration of accessibility in online multi-platform environments designed based on the following contemporary standards:
    a. Current accessibility guidelines including the World Wide Web (W3C) standards?
    b. Universal Design for Learning principles?
2. What was the perceived impact on users with disabilities of the integration of accessibility into online multi-platform learning environments?

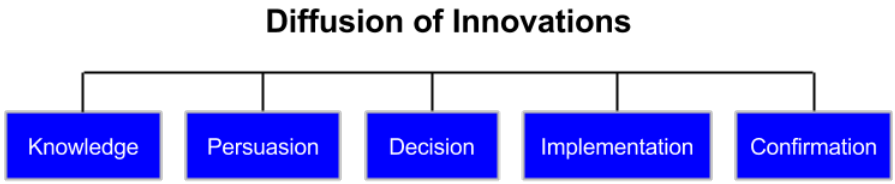
Significance of the Study

The National Council on Disability (NCD) 2011 report (www.ncd.gov/publications/2011/Oct042011) to former President Barack Obama: *The Power of Digital Inclusion: Technology's Impact on Employment Opportunities for People with Disabilities*, recognized virtual world technology (MUVE) use by people with disabilities as a potential tool for gaining employment. The same report also recognized a lack of accessibility as a barrier to people with disabilities using web-based technology for employment related skills. Therefore it is important, from both a legal and ethical standpoint, for programs that use online learning platforms to strive to be accessible to all users. This research study reports findings based on the *EmployAble* project and offers insight to developing MUVE training for people with disabilities.

Conceptual Framework

The study used Roger's diffusion of innovations (2010) as the conceptual framework for structuring data collection and analysis. The implementation of accessible technology based on established guidelines and its re-invention process by practitioners provided a good fit with the innovation diffusion process. Roger's framework is widely used in research (MacVaugh & Schiavone, 2010). The Chapter 2 Literature Review provides a comprehensive explanation of this framework.

Figure 1. Roger's Diffusion of Innovation Framework



Summary of Methodology

Given a lack of research into the area of people with disabilities and how they interact and use accessibility features, the *EmployAble* project provided unique opportunity to chronicle the design and use of these technologies to find out how people with disabilities end up using the features and examples that they do. Using *EmployAble* as a frame of reference for expanding the research on the topic of accessibility and online multi-platform learning environments, Multiple Case study methodology provided a good fit for the research questions of why and how accessibility features were implemented and how end-users interacted with this technology application (Yin, 2014). The *EmployAble* project also provided a current (2011-2012) project timeline and real world application for examination. The *EmployAble* project offered a rich data source because the participants included people with a broad spectrum of disabilities; as defined in technology legislation, Section 508 of the Rehabilitation Act, and as cited in the Center for Applied Special Technology (CAST) [www.cast.org] Universal Design for Learning.

For the purpose of this research study, four people involved in the *EmployAble* project were chosen as participants based on their self identified disability and experience using assistive technology and/or accessible technology for interacting with the web. Further details are expanded upon in Chapter 3, "Methodology."

Role of the Researcher

My interest in this study stems from my work at the Center on Disability Studies, College of Education, at the University of Hawaii at Manoa. I served as the Project Director for the *EmployAble* project, and the importance of this role to the current study is discussed in greater detail in the "Methodology" section. As the media coordinator at the Center on Disability Studies, my responsibilities include the development and design of accessible media, such as websites and electronic print work. My first assignment upon my hire in 2001 was to purchase a large computer monitor for a new faculty member who was visually impaired but was referred to as "blind". My immediate reaction, and one that I still encounter to this day, was why someone who could not see needed a monitor? As I came to learn, the terms "disability" and "technical accessibility" have a wide range of interpretations and individual implications. My next assignment was to design a print program for the Center's annual conference and offer a Braille version for blind attendees to use as a reference to navigate the two-day event. During five years of offering this alternative format, one sighted person picked one up every year as a souvenir, but none of the blind attendees even stopped by to ask for it. The physical Braille version of the 80-page program was over 20 inches thick, had to be bound in three sections, and since it was a direct translation of the print version, had questionable page number references making it difficult to navigate during the conference. I knew there had to be a better way to present the program and enable users, blind or visually impaired, to engage with the same material as everyone else without being completely reliant on someone else to give them information. The research at the time confirmed the increased use of text-to-speech and text-to-braille technology over printed braille documents (Johnson, 1996; Kelly, 2009). Thus I began my quest to develop more user-friendly alternative formats for a disability-focused conference.

As media coordinator I oversee the Center's public website, which at one point was stored on our own server located at one of the University of Hawaii at Manoa's Information Technology Services (ITS) many campus wide locations. I had to research and familiarize myself with some sort of standard or guideline for creating a useable and accessible website for our disability focused Center. In 2002, there were numerous federally funded grants providing information around website accessibility awareness (French & Valdes, 2002; Jackson-Sanborn, Odess-Harnish, & Warren, 2002) and reference to the World Wide Web Consortium (W3C) and their Web Accessibility Initiative (WAI) Web Content Accessibility Guidelines Working Group

(WCAG WG) [www.w3.org/WAI/intro/wcag]. The most recognized and used website evaluator at the time was "Bobby Approved" (Jackson-Sanborn, Odess-Harnish, & Warren, 2002) developed by Chuck Hitchcock at Harvard University (Hitchcock & Meo, 2001) for checking a website's accessibility and posting an icon with a cartoon British policeman or "Bobby" and the title "Bobby approved" or "Section 508 Compliant." This original accessibility checker was frequently used to validate a website's accessibility features (Ellison, 2004). However, at a 2003 Capacity Building Institute in Seattle that I attended, Dr. Hitchcock was asked about the effectiveness of his tool, which he had sold by that time, and he said it's main purpose was to create awareness about web accessibility and not to validate the effectiveness of any website to be fully compliant with any guidelines or Federal law.

In 2008, web content development made a significant change with the advent of what was called "Web 2.0" (Kelly et al., 2009) and the transfer of ownership from website developer/designers to the original authors. End-users could now upload their material directly to the web in the form of a what-you-see-is what-you get (WYSIWYG) template instead of relying on a third party source to code the content in HTML or other web-based computer language. Media formats such as video became user-friendly in the form of Vimeo and YouTube, social media sites such as Facebook, MySpace, and Twitter introduced a new form of social communication, while virtual reality platforms such as Second Life® with a 3-D graphical interface and life-like avatars, opened up the web to the general public (Bertot, Jaeger, & Hansen, 2012; Dreher, Reiners, Dreher, & Dreher, 2009). Now almost anyone could post content to the web without a mediator or organizational reference to hold responsible for accessible content under the Federal Regulation such as Section 508. As the media coordinator, I saw this as an opportunity for our grant-funded projects to directly disseminate and promote their materials in accessible formats for collaboration with other agencies and like-minded entities. The challenge before had been getting the projects to pass on information; now it would be making that information accessible.

Over the past 15 years, I have seen dramatic changes in how the web is used for commerce, entertainment and education. This has also been a time of improvement for people who use assistive technology to interact and communicate with the world. With these changes in technology, comes the need for all users of the web to learn and adapt present approaches to creating accessible content. This is necessary in order to meet the requirements of a diverse

audience. My position as a practitioner of accessible technology and not as an end-user presents a bias not uncommon in the field. The study design purposely includes people who use accessible technology to offer a realistic and authentic insight into how and why accessible technology is used in delivering an online learning platform.

Limitations

The researcher for this proposal co-wrote the *EmployAble* project grant and was Project Director. Steps were taken to address potential bias and provide transparency in regards to data selection and analysis. Given the small sample size and limited scope of the study, further research will need to be done to better understand online accessibility.

Definition of Key Terms

Accessibility. The degree to which a product, device, service, or environment is available to as many people as possible. Accessibility can be viewed as the "ability to access" and benefit from some system or entity. The concept often focuses on people with disabilities or special needs (such as the Convention on the Rights of Persons with Disabilities) and their right of access, enabling the use of assistive technology.

Accessibility is strongly related to universal design when the approach involves "direct access." Which is about making the environment accessible to all people (whether they have a disability or not). An alternative is to provide "indirect access" by having the entity support the use of a person's assistive technology to achieve access (for example, computer screen readers) [Section 508 Rehabilitation Act 1973].

Assistive Technology. Any item, piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of people with disabilities (Assistive Technology Act of 1998 [29 U.S.C. 3002]).

Disability. The definition of a person with a disability is typically defined as someone who (1) has a physical or mental impairment that substantially limits one or more "major life activities," (2) has a record of such an impairment, or (3) is regarded as having such an impairment. (Assistive Technology Act of 1998 [29 U.S.C. 3002]).

Universal Design. A concept or philosophy for designing and delivering products and services that are usable by people with the widest possible range of functional capabilities, which include products and services that are directly accessible (without requiring assistive technologies) and products and services that are interoperable with assistive technologies. (Assistive Technology Act of 1998 [29 U.S.C. 3002]).

Universal Design for Learning. A scientifically valid framework for guiding educational practice that: (a) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and (b) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient (Higher Education Opportunity Act, 2008).

Usability. The extent to which a product (such as a device, service, or environment) can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (International Organization for Standardization [ISO] ISO9241).

CHAPTER 2. REVIEW OF LITERATURE

The guiding research question of this study centered on how accessibility guidelines were adopted in online learning environments for people with disabilities. The following chapter reviews the literature on four major topics of this research study:

1. Accessibility standards;
2. Distance education design for people with disabilities;
3. Multi-User Virtual Environments (MUVE) used as a training tool, specifically for people with disabilities; and
4. Methodological and conceptual frameworks.

Section 508 and the World Wide Web Consortium

Accessibility standards for the web are based on U.S. Federal legislation dating back to Section 504 of the Rehabilitation Act of 1973 (29 U.S.C.A. § 701 et seq.). Although the Internet and Web were in their earliest stages at the time, the idea that people with disabilities had an inherent right to access telecommunications, such as telephones and television, became law in the re-authorization of the Rehabilitation Act in 1986 (Ellcessor, 2010). In the past 40 years since its inception, the Act has been amended with Section 508 (29 U.S.C. § 794d) to provide additional guidance for compliance and to establish a framework for legal and professional standards. To better understand how this framework has evolved and been interpreted, a closer investigation of both Section 508 and the resulting guidelines established by the World Wide Web Consortium (W3C) (www.w3c.org) are warranted.

Section 508 of the Rehabilitation Act

The Rehabilitation Act of 1973 incorporated a civil rights-based approach to disability (Ellcessor, 2010, p. 292) as well as laying the groundwork for accessibility requirements. Section 504 states:

> No otherwise qualified individual with a disability in the United States, as defined in section 705(20) of this title, shall, solely by reason of her or his disability, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance or under any program or activity conducted by any agency or by the United States Postal Service.

(29 U.S.C. 794d. Sec. 504. 1973)

As the Internet was being developed by the US Military (ARPANET) and academic community (CSNET and later, NSFNET) [Abbate, 1999], the Rehabilitation Act was being updated and Section 508 was introduced in 1986 to integrate electronic technology and disability rights:

> The Secretary...shall develop and establish guidelines for electronic equipment accessibility designed to insure that handicapped individuals may use electronic office equipment with or without special peripherals…
>
> (29 USC Sec. 794d. 1986)

The amendment provided no mention of how yet-to-be established guidelines would be enforced (Ellcessor, 2010). Studies of U.S. Federal website compliance (Olalere & Lazar, 2011; Jaeger & Matteson, 2009) validate this lack of guidelines, implementation and enforcement.

Enforcement of the Law

Although the Section 508 regulations have been legislated and amended since their inception in 1986, language within the law has been problematic: "Federal agencies must ensure that this technology is accessible to employees and the public to the extent it does not pose an 'undue burden'" (www.access-board.gov/aba-enforcement/other-resources, para. 4). The "undue burden" clause leaves room for interpretation and has been cited as a reason for non-compliance (Jaeger, 2007; Ellcessor, 2010; Goldberg, 2013).

An additional challenge is the lack of knowledge about who is supposed to be enforcing the law and implementing accessibility of technology (Goldberg, 2013). A 2008 study of California Community Colleges (Farr, et al., 2009) and the accessibility of distance education courses reported a high awareness regarding the need for accessible distance education among administrators, faculty and students but a low awareness of responsibility. In a study of web practitioner barriers to web accessibility (Farrelly, 2011), one of the barriers cited was the lack of accountability for compliance with accessibility laws such as Section 508.

Web accessibility consultant and developer Karl Grove's website (http://www.karlgroves.com/2011/11/15/list-of-web-accessibility-related-litigation-and-settlements/) lists Section 508-related lawsuits in the United States and provides links to the settlements. The number of lawsuits per year are relatively low: only a total of 43 over the past 13 years for an average of 3.3 per year. Most of these cases involved accessibility issues with

websites and were settled with the defendant meeting compliance.

While legislation and awareness about accessibility have resulted in laws being passed to rectify the deficiencies in web usage for people who rely on assistive technology, the evidence of success is limited. Part of the challenge is operational and usable guidelines.

World Wide Web Consortium (W3C)

In 1989, Tim Berners-Lee invented the World Wide Web. It was composed of HyperText Markup Language (HTML), a first client server, and a web browser/editor needed for a "what you see is what you get" (wysiwyg) display of text and graphics to create the visual experience people see today (www.W3C.org/History.html). In 1994, he founded the World Wide Web Consortium (W3C), stating, "The power of the Web is in its universality. Access by everyone regardless of disability" (www.w3c.org/WAI). The W3C mission was, and still is today, to develop international standards for Web accessibility (www.w3c.org/WAI) with an emphasis on protocols and guidelines that ensure long-term growth for the Web (Jacobs 2007).

The W3C Web Accessibility Initiative was formed in 1997 to address the need for established measurements of success, and sustainable guidelines are directed toward three primary groups:

1. Developers of web applications (i.e., browsers such as Mozilla Firefox, Google Chrome, Apple Safari and Microsoft Internet Explorer);
2. Creators of web content (i.e., web developers and designers); and,
3. End-users of assistive technology (Kelly, Sloan, Phipps, Petrie, & Hamilton, 2005).

The guidelines and success criteria are organized around the following four principles, which lay the foundation necessary to access and use content provided on the web:

1. Perceivable - information and user interface components must be presentable to users in ways they can perceive (users must be able to perceive the information being presented so it cannot be invisible to all of their senses);
2. Operable - user interface components and navigation must be operable (users must be able to operate the interface and cannot require interaction that a user cannot perform);
3. Understandable - information and the operation of user interface must be understandable (users must be able to understand the information as well as the operation of the user interface); and

4. Robust - content must be robust enough that it can be interpreted reliably by a wide variety of user agents, including assistive technologies (as technologies and user agents evolve, the content should remain accessible) [www.w3c.org/WAI/intro/people-use-web/principles].

These principles give a broad level of guidance but offer few specifics for designers to follow. “Perceivable” by all the senses when accessing the web narrows to just two, sight and sound. “Operable” navigation becomes subjective beyond the linear suggested format of web page menus and fillable forms (mouse-free navigation). “Understandable” information and user operational interface becomes problematic with targeted audiences with unknown levels of vocabulary. “Robust” content delivery for multi-modal output becomes challenging as the number of options increases with each additional piece of content material. Interpretation of these principles presents the challenge of constantly updated output devices, such as screen size or resolution and improved input assistive technologies, such as voice command. One of the suggested practices given by the W3C for evaluating website accessibility is to have a person with a disability test it with their assistive technology: however, there are no guidelines for specifying or outlining which assistive technologies or disabilities should be represented.

The resulting accessibility guidelines based on the four principles, are referred to as the Web Content Accessibility Guidelines (WCAG) with structured techniques described in three levels: (a) sufficient, (b) advisory, and (c) failures. These standards are only suggestions and to be in conformance, as stated by the W3C, requires adhering to five requirements, each with its own three levels. The W3C definition of technical accessibility is “users’ assistive technologies will work with Web technologies AND when the accessibility features of mainstream technologies will work with the technology” (www.w3c.org/TR/UNDERSTANDING-WCAG20/conformance.html, para. 48). These standards are widely considered to be the international benchmark for web accessibility and have been adopted by many countries as a standard for disability rights legislation around the Web (Kelly, et al., 2005; Ellcessor, 2010; Capra et al., 2012; Farrelly, 2011; Hansen, Davies, & Hansen, 2008; Brizee, Sousa, & Driscoll, 2012; Fernandes, Costa, Duarte, & Carriço, 2012; Jaeger, 2008; Miñón, Moreno, Martínez, & Abascal, 2014).

Although these accessibility guidelines have been available and updated on a regular basis, their use by web developers for designing accessible online environments is not well

documented. Jaeger (2008) and Friedmeyer-Trainor (2012) both cited a lack of accessible design, as defined by the W3C, in U.S. Federal Agency websites. Farrelly (2011) showed a lack of `knowledge about web accessibility by web developers, despite their having an awareness of legislation about the topic. This apparent mismatch of awareness and priority in implementing accessibility standards demonstrates the need for further research.

Universal Design

Universal Design (UD) as a concept was first developed by Ronald Mace at the Center for Universal Design (CUD) at North Carolina State University and primarily addressed the design of the physical environment and how design could be used to address the needs of both people with physical and cognitive disabilities and the general population (Story, Mueller, & Mace, 1998). CUD defined UD as: "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (p. 32). In 1997 they developed seven guiding principles: (a) equitable use, (b) flexibility in use. (c) simple and intuitive, (d) perceptible information, (e) tolerance for error, (f) low physical effort, and (g) size and space for approach and use. These guiding principles are the foundation for Universal Design for Learning (UDL) and have similarities to the W3C web guidelines. The need for an overall structure in designing accessible community areas applies to both architecture and publicly-used modes of communication.

Universal Design as a teaching strategy was developed by the Center for Applied Special Technology (CAST) [www.cast.org] and has been applied as Universal Design for Learning (UDL). There are three guiding UDL principles: (a) multiple means of representation, (b) multiple means of action and expression, and (c) multiple means of expression. These have been referenced in the literature (Burgstahler, 2011) along with nine guidelines for implementation (Table 1). Although the original concept of UDL included in-person classroom teaching using technology, along with content delivery strategies based on cognitive retention, the transferability to online learning environments was rapidly realized (Roberts, 2004; Sapp, 2009; Poore-Pariseau, 2010).

Table 1. Universal Design for Learning Principles and Guidelines

Multiple Means of Representation	Multiple Means of Action and Expression	Multiple Means of Engagement
(1) Provide options for perception. (2) Provide options for language and symbols. (3) Provide options for comprehension.	(4) Provide options for physical action. (5) Provide options for expressive skills and fluency. (6) Provide options for executive functions.	(7) Provide options for recruiting interest. (8) Provide options for sustaining effort and persistence. (9) Provide options for self-regulation.

The UD approach has been supported in federal legislation. For example, the Higher Education Opportunity Act (HEOA) of 2008 (P.L. 110-315. 2008.) established the statutory definition for:

> "Universal design for learning to be a scientifically valid framework for guiding educational practice that—(A) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and (B) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient."

Burgstahler (2011, p.5) goes on to point out that UDL has never been scientifically validated and "research is not plentiful on the efficacy of UD as a collection of strategies to increase learning for a diverse audience." Similar to the W3C guidelines, validation as a successful strategy with empirical evidence is not reflected in the literature.

Rose et al. (2005) described how assistive technology and UDL were compatible and complementary. Overall, the study indicated (a) the difference between UDL, a strategy, and assistive technology, a tool, and (b) the dependence of UDL on assistive technology in order for the strategy to be effective in teaching students with disabilities, and (c) the need for additional accessibility standards for content (material such as textbooks) so they can be delivered electronically in the form of text, audio, and braille. The latter finding was in response to legislation requiring alternative forms of textbooks for students with disabilities. The

introduction of UDL as a web-based accessibility issue and complement to the W3C guidelines is highlighted in articles on blended and online classes (Santovec, 2005; Burgstahler & Cory, 2008; Ortiz, McCann, Rayphand, & Leong, 2009; Edyburn, 2010; Czerkawski & Bumun, 2013).

The overlapping accessibility guidelines of the W3C and UDL highlight the compelling issue of recognized standards. The accessibility standards proposed in the Rose UDL study for content coincide with the W3C guidelines for providing web accessible content.

Online Design for People with Disabilities

Research on designing accessible online learning environments is limited but falls into two distinct categories: (a) retrofitting existing platforms to adhere to Section 508 regulations, and (b) designing platform specifically for people with disabilities. Although there is ample literature on suggestive and hypothetical applications for creating inclusive and accessible online environments, the results and conclusions remain mixed (Ramakrishnan et al., 2009; Jaeger & Bo, 2009; Farrelly, 2011; Fernandes, Costa, Duarte, & Carriço, 2012; Friedmeyer-Trainor, Vernon, & Lynch, 2012; Lazar et al., 2013).

Retrofitting Existing Platforms

The online writing lab (OWL) at Purdue University, known as a model to many, underwent a redesign in 2004 to accommodate a need for tutoring students with disabilities (Salvo, Ren, Brizee, & Conard-Salvo, 2009). The website averaged over 30 million hits a year prior to the redesign and increased to 100 million afterward. However, user complaints about usability resulted in Purdue initiating a second redesign with campus usability experts being brought in for the process. There is no mention or reference to the W3C or UDL in the study and end-users were defined as the general population as a whole, not the target group of people with disabilities. Once the accessibility issues were noted and a new redesign process begun, a thorough use of the W3C guidelines and UDL were implemented. After making changes to the website to reflect the new dynamic of accessibility, problems still persisted and eventually, the Purdue disability support office was contacted and asked for input. After the students with disabilities (in this case, two blind users) assessed the website, (Brizee, Sousa, & Driscoll, 2012) it became compliant.

The use of automated web-based programs to validate W3C compliance is well documented (Ramakrishnan, Mahmud, Borodin, Islam, & Ahmed, 2009; Vigo & Brajnik, 2011;

Friedmeyer-Trainor, Vernon, & Lynch, 2012; Matausch, Peböck, & Pühretmair, 2012; Lazar et al., 2013; Miñón, Moreno, Martínez, & Abascal, 2014); however, as with the Purdue example, the W3C recommendation to have the end-users, people with disabilities, actually test and provide input in creating an accessible and usable online environment is still rare.

Designing for People with Disabilities

The next group of research focuses on studies directed toward users with specific disabilities. The research highlights the accessibility features found in some online programs, and in some cases, gives specific methods for improving accessibility based on the interaction with end-users with disabilities.

Babu and Singh (2013) reported a task-oriented, user-centered, multi-method evaluation (TUME) approach for a solution-oriented assessment of accessibility, usability, and utility of Web-based applications. This study focused on incorporating the W3C guidelines into observed behaviors with blind users. They used the websites (in this case a Learning Management System [LMS]) to evaluate and improve the final set of recommendations, named TUME, for modeling other accessibility related learning environments. Findings indicated that end-user participation (people with disabilities) is a major factor in identifying potential problems with accessibility. It should be noted that co-author Babu is a blind user of technology.

Other studies that utilized end-user participation in evaluating accessibility also focused on blind users (Ferreira, da Silveira, Capra, & Ferreira, 2012; González, Moreno, & Martínez, 2012). In one study specifically evaluating web accessibility using people with disabilities in the evaluation (Capra, et al., 2012), the focus was on "functionally illiterate" people interacting with the web and did not address any accessibility guidelines. Another study surveyed end-user experiences with online learning but did not offer any insight to creating a more accessible learning environment (Seale, Draffan, & Wald, 2009). However, most studies rely on technical experts to formulate accessible models without any end-user participation (Sapp, 2007; Oud, 2011; González, Moreno, & Martínez, 2012; Matausch, Peböck, & Pühretmair, 2012; Miñón, Moreno, Martínez, & Abascal, 2014)**.**

The gap in research on adopting accessible guidelines is apparent in the literature, especially in identifying end-user needs. None of the reviewed studies used disabled reviewers with multiple disabilities for an evaluation and assessment of accessibility of platforms or content being delivered through the web. Few if any people with disabilities are included in the

process of web accessibility design or follow up in these studies.

This research study addresses the gaps in two significate ways by identifying both the end-users by specific disability and by using the two methods for accessibility, the W3C guidelines and UDL, for their evaluation of accessibility.

Multi User Virtual Environments (MUVE) and People with Disabilities

The National Council on Disability (NCD) 2011 report former President Obama recognized virtual world technology (MUVE) use by people with disabilities as a potential tool for gaining employment (www.ncd.gov/publications/2011/Oct042011). The same report also recognized a lack of accessibility as a barrier to people with disabilities using web-based technology for employment related skills.

Using MUVE for professional training has been established in the literature as a viable tool (Chodos, Stroulia, & Naeimi, 2009) with research studies in the Aerospace Industry (Abate, Guida, Leoncini, Nappi, & Ricciardi, 2009), medical surgery team development (Seymour, et al., 2002) and health education (Mantovani, 2003; Boulos, Hetherington, & Wheeler, 2007; Neuendorf, & Simpson, 2010). The use of MUVE in formal education is reflected in articles describing virtual online classrooms and the benefits of being "immersed" in the virtual environment for experiencing unique learning opportunities (Kluge, & Riley, 2008; Bowers, Ragas & Neely, 2009; Hew & Cheung, 2010). Use of MUVE as a research tool has been proposed and documented (Moschini, 2010; Murthy, 2011). Architectural modeling in MUVE as a training tool for students to visualize physical accessibility compliance has also been used (Ang, et al., 2010).

Research in using computer simulated models, the precursor to MUVE, of an office work environment with traumatic brain injury (TBI) patients resulted in promising findings. Patients with TBI using the computer-simulated models showed increased memory retention compared to the control group using conventional training methods (Matheis, Schultheis, Tiersky, DeLuca, & Rizzo, 2007). This research study was based on early work in physical rehabilitation using a 3-D computer model to assist patients with learning basic life skills such new technologies for mobility (Rizzo & Buckwalter, 1997; Schultheis & Rizzo, 2001; Rizzo, Schultheis, Kerns, & Mateer, 2004; Rose, Brooks, & Rizzo, 2005).

The use of MUVE for training people with disabilities in life skills goes beyond

rehabilitation (Stendal, 2012) to include promoting social skills needed for independent living (Stendal, Molka-Danielsen, Munkvold, & Balandin, 2011). An entire MUVE site in Second Life® designed by Virtual Ability, Inc., (www.virtualability.org), a non-profit organization dedicated to creating disability-focused MUVE simulations and education surrounding disability issues, has a site that models independent living for people with disabilities (Krueger, Ludwig, & Ludwig, 2009). Virtual Ability also has a dedicated training area for learning the MUVE browser and engaging its accessibility features. One of the challenges with MUVE technology is accessibility, because the interface can have a high learning curve (Hansen, Davies, & Hansen, 2008) that requires extensive training. It is also visually-based, which can be problematic for blind users. However, there are established disability focused communities fully engaged with MUVE technology (Stendal, 2012).

Although the use of MUVE has been identified as an emerging technology, no existing research on how to create an accessible platform has been established. Disability specific browsers, such as Radegast (www.radegast.org) for blind and visually impaired users, are available with little known research being published on user experience or adaptation.

Conceptual and Methodological Frameworks

Diffusion of Innovations

Roger's diffusion of innovations (DOI) theory was the conceptual framework for this study (Rogers, 2010). Its analysis of the factors involved with adaptation of innovation, such as technology, provided a good fit for research on accessibility technology design and implementation. Roger's model of the decision process, attributes of innovations, types of adapters, layout of networks, and organizational structures, provided the ideal framework from which to organize the factors for selection or rejection of technology-based guidelines.

For this study, the emphasis was on the implementation stage (p. 179) of the decision process as outlined in Roger's theory. The use of accessibility as a guideline for web development, content creation, and overall strategy for creating online learning environments, lent itself to the decision process of what and how to implement guidelines. In particular, the emphasis on re-inventing an innovation (p. 180) during the adoption process provided an area for comparison with other studies involving people with disabilities using online technology for learning.

Another aspect of this study that made it a good fit with DOI was the unique barrier each participant brought to engaging the web. Technical assistive and accessible guidelines and requirements were different for the targeted end-users with disabilities. Visually-impaired and blind people use screen readers or enhancement software to engage the web. Deaf and hearing impaired people require text-based communication, such as captioning, to interact or follow a video. Those with traumatic brain injury or an intellectual disability benefit from UDL applied instruction. The cumulative set of guidelines, W3C and UDL, attempt to cover this wide range of challenges while the ongoing and updated legal requirements attempt to narrow the focus of barriers and provide a clearer definition of expectations.

Summary

This literature review provided the background for this study, including literature about accessibility, Universal Design, legislation surrounding access to technology for people with disabilities and design challenges for accessible online learning platforms. It also provided the foundation for both a conceptual and methodological framework from which to structure the research and to answer the research questions surrounding accessible design. A high awareness of the need for accessibility is well documented but its adoption is not. Legislation has not resulted in full compliance with accessibility standards, even for government agency websites, almost 20 years after its adoption.

CHAPTER 3. METHODOLOGY

The following section outlines the structure and justification for using multiple-case study methodology in researching the topic of online accessibility and in particular, the *EmployAble* project as a source of data and inquiry for this study. The section outlines Roger's diffusion of innovation as an appropriate conceptual framework for this study as opposed to alternative frameworks that will be discussed. The section also outlines the selection process for the four participants and the context in which they were chosen. The documents procedures for collecting data through semi-structured interviews, and triangulation with existing surveys from the *EmployAble* project. Finally, the section discusses validation strategies consistent with case study, along with methods for data analysis.

Research Design

The *EmployAble* project upon which this research study was based provided an opportunity to examine in detail how accessibility is applied, reconfigured, and utilized in online learning platforms. It also provided an opportunity to investigate how people with disabilities use both assistive and accessible technologies along with mainstream technologies, and how their experiences as end-users can empower the distance learning experience for marginalized populations.

The Multiple-Case Study Method

The study used a descriptive multiple-case study methodology. As outlined in Stake's book (Stake, 2013), general rules for selecting cases include: (a) Are the cases relevant to the question? (b) Do the cases provide diversity across contexts? and (c) Do the cases provide good opportunities to learn about complexity and contexts? Given a lack of research into the area of people with disabilities and how they interact and use online accessibility features (Farrelly, 2011), the *EmployAble* project provides a unique opportunity to chronicle the design and use of these technologies and find out (a) why designers implement accessibility features, (b) how end-users (people with disabilities) interact with accessibility features, and (c) how the dynamics between practitioner and user influences the end result of an accessible online learning platform. Based on Yin's 2014 book, *Case study research: Design and methods*, the five components of

case study research design are: (a) study's questions, (b) propositions, (c) units of analysis, (d) logic linking data to propositions, and (e) criteria for interpreting the findings.

Yin's Five Components

Study questions. The research questions for this study were focused on how four of the *EmployAble* project's participants used, and their attitudes toward, accessible web-based and MUVE instruction for people with disabilities. The questions of "how" and "why" needed to be addressed about accessibility, as opposed to more studied areas such as attitudes about using web-based and MUVE technology the experience of being "immersed" in MUVE, or the social dynamics of being in the virtual environment.

Study propositions. The *EmployAble* project established expectations of training people with disabilities for employment skills using a combination of asynchronous web-based instruction, synchronous online mentoring sessions and its MUVE simulation in Second Life®. Beyond just following the law regarding technical accessibility features (Section 508), the project was dedicated to setting an example of accessibility. This included modeling the web-based instruction modules and Second Life® simulation as prime examples of technical accessibility in ways they can provide the necessary supports for people with disabilities. Creating an accessible environment in all aspects of the project was paramount for its success.

Units of analysis. There were multiple units of analysis available for research within the boundaries of the *EmployAble* project pilot study. These included MUVE disability-focused communities, individual participants' outcomes, employers/evaluators of the relevance of the project to their business models and needs, expert evaluations of the project's feasibility, expectations of the grant/funding agency, and the people directly involved in creating the project. The scope of this proposal and unit of analysis selected, focused on the technical accessibility and usability of the three online learning platforms demonstrated in the *EmployAble* project. The creation of these platforms went beyond being expert-based and involved the end-users in determining the best solution for a dynamic and meaningful learning experience.

Data link to proposition. The data collected for the study were drawn from open-ended questions in the form of semi-structured interviews, and pre and post-surveys conducted during the EmployAble project. The data revealed how end–users interacted and related usability to applied accessibility features. Four *EmployAble* participants, people who have self-identified as people with disabilities, were interviewed for this case study in order to develop a better

understanding of how and why people with disabilities select and interact with accessibility features.

Criteria for interpreting the findings. The findings were interpreted by analyzing what the four *EmployAble* participants reported about the usefulness of accessibility features as well as self-reported interaction with these features. The assumption was that the intended rationale on the part of the designers in implementing accessibility features may not have the desired outcomes or expected usefulness that they anticipated. The interaction of people with disabilities with technology is varied and not well established as found in the literature review.

Research Questions

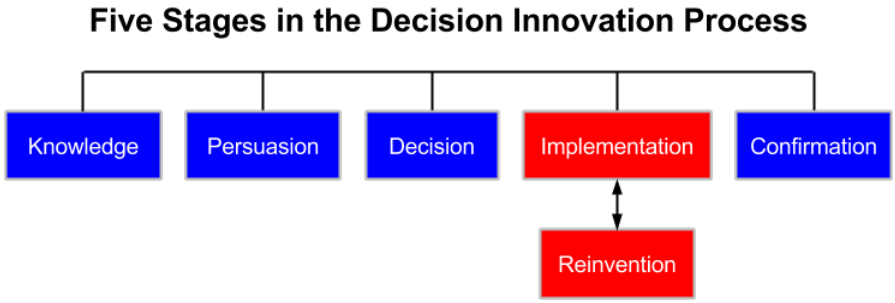
This study researched how and why technical accessibility was adapted, and received in online learning environments as demonstrated by participation in the *EmployAble* project. As Yin illustrates in Table 1, three conditions differentiate a case study from alternative methods: (a) the form of the research question, (b) control of behavioral events and, (c) the focus on complementary events (Yin, 2014, p. 9). The research questions proposed by this study provided a good fit for case study research methodology by asking how and why questions and no invention or control of behavior events. The focus on the *EmployAble* project offered a unique and current (2012-14) set of data.

Table 2. Relevant Situations for Different Research Methods

Method	Form of Research Question	Requires Control of Behavior Events	Focus on Contemporary Events
Experiment	How, Why?	Yes	Yes
Survey	Who, What, Where, How Many, How Much?	No	Yes
Archival Analysis	Who, What, Where, How Many, How Much?	No	No
History	How, Why	No	No
Case Study	How, Why	No	Yes

Conceptual Framework

Figure 2. Diffusion of Innovation Framework Implementation/Reinvention



The study used Roger's diffusion of innovation (DOI) [Roger, 2010] conceptual framework with an emphasis on the implementation stage of the decision innovation process, as the point of reference for evaluating the implementation of online accessibility during the E*mployAble* project. DOI is suitable as a framework because it can be used to examine innovation diffusion as it pertains to accessibility and web-based knowledge transfer for people with disabilities. The process of the first three stages in Rogers' theory as it applies to technical accessibility guidelines is well documented in the literature (Farrelly, 2011; et al.): (a) knowledge, through federally funded grant projects for creating awareness (in defined communities such as entities funded by the federal and local government); (b) persuasion, through legislation, such as Section 508 and the Americans with Disabilities Act (ADA); and (c) decision, the resulting outcome of questionable but real decision of partial or non-compliance. The guiding proposition for this study was the fourth stage of implementation as illustrated by how accessibility guidelines were used and re-invented for a best fit adoption to the *EmployAble* project online learning environments.

To better understand why any re-invention process occurs, Rogers provides eight reasons for individuals or organizations to not adapt the original concept in its entirety. These include, (a) difficult to understand, (b) lack of detailed knowledge about the innovation, (c) general in concept with many possible applications, (d) used to solve a wide range of problems, (e) pseudo-re-invention in a cosmetic way for localized ownership, (f) decentralized diffusion systems may require end-users to innovate without a structured plan, (g) innovation must be altered to match the structure of an organization from which is it adopting, or (h) late adoption benefiting from the learning curve of earlier adopters. These factors extend to the assistive technology world as well with people being given tools which can be difficult to use but are expected to solve a wide

range of problems (Carver, Ganus, Ivey, Plummer, & Eubank, 2016; Kaye, Yeager, & Reed, 2008; Riemer-Reiss & Wacker, 2000).

An example of a case study using Rogers' DOI and the step of re-invention to implement standards or guidelines originating from legislation is *Promoting Basic Accessibility in the Home* (Nishita, et al., 2007). This University of Southern California study looked at how legislation for creating accessible housing was altered or reinvented at a local level to accommodate the opposition to its adoption. Similarities include recognized standards for creating an accessible environment that are misinterpreted as an "undue" burden by housing builders, or in the case of the W3C guidelines, web practitioners', sometimes vague recognition and understanding of "accessibility" and its application to the end product, such as housing or websites, and lastly, the process of reinventing parts of the guidelines to accommodate the end goal implementation. This illustrates Roger's theory about how innovation is diffused and the nature of its possible changes, and more to the point (Hayes, 1996), that dynamic reinvention does occur by adaptors.

Alternative Technology Focused Conceptual Frameworks

Besides Rogers DOI, two other conceptual frameworks were explored for this research study: Davis's Technology Acceptance Model (TAM) [Davis 1986] and Hall's Concerns-Based Adoption Model (CBAM) [Hall 1974]. Both of these models seek to explain how technology is adopted by individuals or organizations.

Davis's TAM is centered more on the innovation itself (Straub, 2009) having its origins in computer science and what the user's perception is of the technology. A key aspect of TAM is Davis's belief that a "perceived ease of use to self-efficacy" was important to adoption (Straub, 2009 p. 638). The reasons for accessibility adoption are grounded in law and the end-user's need to use their assistive technology rather than the perception of it being easy. Criticisms of the TAM include lack of acknowledgment of individual differences and characteristics of end-users. This study focuses on the differences of the end-users' use of technology so TAM was not appropriate.

Hall's CBAM is targeted toward adopters with concerns about how a technology innovation will be used, for a better understanding of how to get people to accept it. The CBAM assumes the end user inherently does not want the innovation in the first place and evaluates how the process of acceptance within a group can be achieved through addressing their collective

concerns about the technology innovation. Since this study focuses on end-users use of the innovation and not on the decision of acceptance, the CBAM was not considered appropriate.

Participants and Context

Participants

Four of 50 participants from the *EmployAble* project who completed all three phases of the project and represented the three major disability areas recognized as by Section 508 and the W3C as benefiting from accessible technology were selected for this study:

1. "John" has a visual impairment and uses a screen reader;
2. "Anna" has a hearing impairment and relies on text based communication;
3. "George" has an intellectual disability;
4. "Curt" has Traumatic Brain Injury (TBI).

The purposeful and maximum variation sampling of these participants provided an opportunity to encompass a diverse population within the limited scope of the study (Cohen, Manion, & Morrison, 2011). The researcher as the content expert provided an insight into the process by which the four *EmployAble* participants were able to interact with the online *EmployAble* curriculum. The four participants who completed the program were selected to represent diversity of disability because of the different assistive technologies they use or learning challenges that they have. Accessibility needs in the context of online learning are addressed for each of three major categories of disability in the W3C Web Accessibility Guidelines (www.w3c.org/WAI) and Universal Design for Learning principles (www.cast.org): (a) visual impairment (screen reader or audio description), (b) hearing impairment (text alternatives to sound), and (c) intellectual or developmental disability (navigation through menu driven web-based programs).

Study Setting

The *EmployAble* project provided the boundaries for this research study. Interviews with selected participants and their survey data from the *EmployAble* pilot study were the basis for the study. A detailed examination of the *EmployAble* project is outlined in Chapter 4.

Role of the Researcher

I co-wrote the *EmployAble* project grant proposal and served as the Project Director for the duration of the project. Although I did not work exclusively with each of the study participants, I did oversee the accessibility requirements for the informational website resources and online interview module. I also conducted mentor group discussions with seven participants, including one of the selected participants for this research project.

Instrumentation and Procedures

The instruments for data collection included semi-structured interviews with four participants who completed all three phases of the *EmployAble* project. Data were also used from previously collected *EmployAble* project pre and post participant online surveys. An open-ended interview protocol was developed for new data collected from interviews with the participants following guidelines as outlined in McNamara (2009). The interview questions (see Appendix A) focused on how the users perceived and adopted implementation of accessibility features that incorporated into the *EmployAble* online instruction module and MUVE simulation in Second Life®. The questions also followed the principles of qualitative interview research methods per Turner (2010). After IRB approval, the interview questions were reviewed for validity and reliability by an accessibility expert at the University of Hawaii, Center on Disability Studies.

Data Collection

Data for this research project consisted of IRB approved *EmployAble* project surveys conducted on LimeSurvey (an online open-source survey program), audio recordings and transcripts of one participant interview, and written interview transcripts of the other three participants. Both the surveys and audio recordings were securely stored in the Dedoose qualitative program (Glasow, 2005).

A semi-structured interview protocol was developed for the four individual interviews along with an IRB-approved questionnaire. To operationalize the questionnaire (Cohen, et al., 2011), the open-ended questions focused on three major areas: (a) awareness of accessibility standards use (i.e., World Wide Web Consortium), (b) understanding of accessibility implementation procedures aligned with Universal Design for Learning, and (c) how accessibility was established in the three learning areas (web-based instruction module, mentor

online sessions, and the Second Life® simulation) of the *EmployAble* project. The interviews with the four case study participants were completed in November 2015. They were recorded and translated using a digital recorder and *Dragon 12* (www.nuance.com), and then saved in the qualitative online program, *Dedoose* (www.dedoose.com) for coding (Creswell & Clark, 2011).

Data Analysis

Data Management

The resulting transcriptions of the one recorded interview made by the researcher using the *Dragon 12* speech to text, and the other three written responses were stored in a password protected folder. The original participant numbers assigned during the *EmployAble* project to ensure confidentiality were used to identify this study's participants (Turner, 2010) in order to ensure the continuation of confidentiality.

Although the *EmployAble* project pilot study was University of Hawaii Institutional Review Board (IRB) approved, an additional request was made regarding the interview questions and this research study as a standalone entity. Three of the interviewees requested that the interview questions be emailed to them in order to give them time to reflect on their answers while one wanted the interview conducted on Skype. The transcripts of all interviews were uploaded to the qualitative online program, Dedoose (www.dedoose.com) for secured storage and the two cycles of coding by two raters.

Initial Analysis

To develop themes linked to the research questions, an open coding process was first used to identify initial codes to be grouped from a single interview transcription. Codes focusing on the awareness of disability, implementation or integration of Universal Design principles and knowledge of assistive technology were given the first priority in the process. *Dedoose* was used to record the coding process, identify repeated codes between interview transcripts, and store the initial coding (Saldaña, 2009).

Following Saldaña's "The Coding Manual for Qualitative Researchers" a two-cycle system was followed to refine the codes after the initial coding from the first interviewee, Curt. Ten codes were identified by the researcher based on their relevancy to the research questions and disability awareness regarding technology use such as assistive technology and mainstream technology use. Next, the ten codes were given to the second rater, definitions agreed upon and

applied to the four interviews. Then the researcher and second rater discussed the codes for consistency in meaning and application within the context of the research questions. A second set, or second coding cycle, began with combining or eliminating codes deemed redundant or unnecessary as some of the codes such as "accessibility awareness" and "accessibility knowledge" were difficult to distinguish and to apply to the interviews. New insights into the interviewee's' motivation for using technology such as "confidence building" were added into the codebook (see Appendix B). The process included the introduction of subcodes for clarification between internal and external awareness of disability and the use and knowledge of assistive technology and accessible technology. The codes were reduced to seven and three sets of two subcodes each added to the codes: disability, assistive technology, and accessibility technology. The four interviews were coded again, discussed between the raters, and a 90% inter-rater agreement of the applied codes reached.

Higher Level Analysis

Axial codes were then applied to groups of the similar open codes that have a common theme (Cohen, Manion, & Morrison, 2011, p. 561-562). Themes were evaluated for relevancy to the research questions on accessibility implementation and the conceptual framework section of re-invention and how the accessibility guidelines were adapted or altered. The coded themes were then given to an outside faculty member at the Center on Disability Studies for accuracy and bias overview.

Trustworthiness

To ensure trustworthiness of the study, qualitative controls have been used based on accepted methods and focused on case study and multiple case study methodology.

Construct Validity

Concepts relating to the topic of research were agreed upon through existing literature, legal definitions, and participant feedback. In particular, the term "accessibility" and how it is operationalized within the context of the *EmployAble* project pilot study were outlined and evaluated for reinforcing the concept as it relates to interacting with web-based technology. Interview participants were asked to state their interpretation of "accessibility" and theme development was based on the agreed terms originating from the literature and legal definitions

(Yin, 2014, p. 46; Cohen, Manion, & Morrison, 2011, p. 295). These were extended to other definitions including disability and assistive technology.

Internal Validity

Transcripts of the interviews were reviewed by the participants to ensure accuracy in reporting (Creswell & Clark, 2011, p. 211). Data collected from the surveys, the interview questions, and the coded themes were reviewed by an outside source for transparency and accuracy in reporting a logical sequence leading to the research questions. Alternative explanations were introduced for discussion and examination in chapter 5 findings and conclusions (Yin, 2014, p. 47; Creswell & Clark, 2011, p. 212; Cohen, Manion, & Morrison, 2011 p. 295).

External Validity

The study's findings and conclusions provide a meaningful "best practices" or logic model for creating future universal designed online learning platforms for people with disabilities (Cohen, Manion, & Morrison, 2014). To address external threats to the study, the findings and conclusions were reviewed by outside evaluators at the Center on Disability Studies who are familiar with the application of accessibility and Universal Design for Learning in an educational setting.

Reliability

To ensure reliability in the study, data collection procedures as outlined in the proceeding paragraphs on validity were documented and presented in the final reporting. Concept validation through mutual agreement of terms derived through peer-reviewed literature, outside expert review, and participant checking, reinforced reliability. Internal checking of interview transcripts by the interviewees for accuracy, along with coding and theme development checking by an outside experts on accessibility and universal design topics, provided a sound foundation for reliable data sets being linked to the research questions and final conclusions for the study (Yin, 2014).

Rigor and Bias

One obvious area of bias was that the researcher, as Project Director, supervised personnel and activities under the *EmployAble* project. While the researcher's position provided an in-

depth understanding of the *EmployAble* project, it could also limit the researcher's objectivity. The procedures outlined under Validity and Reliability were intended to limit bias in this case.

Bias can also occur in assumptions made about the end-users and the practitioners of technical assistance. People with disabilities as end-users of applied accessible technology through assistive technology have not been adequately represented in research or literature. Part of the challenge in addressing this issue is the unique application of assistive technology each end-user will have and their level of experience with their assistive technology. Practitioners of accessible technology through web-based content have historically been non-users of assistive technology and have relied on established guidelines of the W3C or Universal Design principles.

To address these areas of potential bias in the study, end-users with defined and different disabilities were interviewed for their perspectives in interacting with the applied accessibility technology and universal design guidelines as provided by the *EmployAble* project. Outside experts were used to review the data and findings for bias.

Summary

This research study outlined a multiple case study methodology based on the *EmployAble* project, using original project survey data and open-ended interviews with four participants, each selected to represent a broad base of end users of accessible technology. Through theme development of the coded interview transcripts and surveys, the research questions of how and why accessibility was implemented and used by people with disabilities was explored. The findings give a richer insight to how the process of creating online learning environments is achieved and hopefully, lead to new understanding of how accessibility guidelines work within the real world context of universal design as a standard for future online learning.

CHAPTER 4. STUDY SETTING

In January 2012, the Kessler Foundation funded a two-year pilot project, *EmployAble*, to train people with disabilities in employment skills using innovative technology. The Center on Disabilities Studies (CDS), College of Education, University of Hawaii at Manoa was selected, along with four other institutions, from an initial 266 proposals to be funded. Partners in the grant included *Virtual Ability, Inc.*, a non-profit Colorado-based company providing support communities for people with disabilities in online virtual worlds and *Abilicorp*, a California-based disability-focused employment agency. *EmployAble* was staffed with two co-Principal Investigators, a Project Director, two content experts, and an administrative assistant. The project also utilized expertise from its partners, a seven-member advisory board, an outside evaluator from Rutgers University, and a Kessler Foundation project officer. Four of the six staff members, the CEOs of both partner organizations, and five of the seven advisory board members were people with disabilities.

The scope of the *EmployAble* project included providing mentoring opportunities for the participants, demonstrating assistive technology and accommodations for both employees and employers, and providing accessible online instruction in employment skills using web-based programs and a virtual world site. The project used Second Life®, a MUVE launched by Linden Labs in June 2003, to conduct training simulations. The areas of emphasis included a *Skill-Builder* section, where employment skills were taught and practiced using MUVE; *Access Info*, which included disability resources about technical accessibility, assistive technology, and workplace accommodations; and *Match Maker*, where employers, employees, and mentors could exchange information and participant in a mentoring program. Project partner *Virtual Ability Inc.* built out the simulations, or SIMS, on their Second Life® Island, and conducted formal Second Life® training for participants, staff, and advisory board members. The *EmployAble* project staff were responsible for developing the criteria and online modules for training the participants and conducting the formalized training within the Second Life® SIM. Partner *AbiliCorp* was contracted to identify potential employers and develop a mentoring process using online communication programs. The advisory board was charged with giving advice to the staff about the project and promoting it within their own constituencies.

The *EmployAble* project staff was also responsible for coordinating online meetings with the project partners and the advisory board. The decision to have all meetings inside Second Life® was made at the beginning of the project. Accessibility features determined the modes of online communication; and guidelines from the World Wide Web Consortium (W3C) [www.w3c.org] and Universal Design for Learning principles (UDL) [www.cast.org] were used to ensure all meetings were available and comprehensible to everyone invited. The *EmployAble* Project Director was charged with establishing and enforcing the accessibility standards for the online instruction and promotion of the project. *Virtual Abilities Inc.* also used Universal Design Principles for physical access in designing the Second Life® simulations (Krueger, Ludwig, & Ludwig, 2009).

Participants were recruited from throughout the United States via disability related listservs and project contacts. Fifty-one participants were accepted into the pilot program. The project also recruited ten mentors with significant professional experience and/or disabilities. Participants completed several activities, both individually and as a group, including:

1. Participating in an online orientation session and a training session in Second Life®.
2. Meeting online at least twice a month with a group of 2-4 peers and a mentor via Skype, Google Hangouts, or Second Life®.
3. Completing an online module on preparing for a job interview.
4. Reviewing online interactive resources such as searching for a job, disclosing a disability, and building a resume.
5. Utilizing online productivity and social media tools, such as LinkedIn, Facebook, Second Life®, Skype and Google tools, to conduct job searches, make connections with employers, build a resume, and conduct an interview.
6. Developing a resume, soliciting feedback, revising and disseminating the resume.
7. Practicing for a job interview via Skype or Second Life®, and reviewing a recording of the interview.

As part of the pilot study, participants were asked to complete a pre-survey, mid-survey and post-survey. Thirty percent of the original participants completed the final survey, and of these respondents, 84% percent indicated that *EmployAble* helped prepare them to find or retain a job. During the course of the project, 23.1% of participants received job offers, 38.5% had a job interview, 53% said they learned important employment skills, 77% indicated that

EmployAble improved their technology skills, and 85% stated *EmployAble* improved their ability to network with others. The *EmployAble* Pilot Study concluded with a number of implications for practice in the area of employment preparation for individuals with disabilities. Specifically:

1. Online technology, when used in interactive, accessible and creative ways, can improve skill development and preparation for employment for individuals with disabilities.
2. Mentors are a valuable resource for job seekers with disabilities.
3. People with disabilities need access to online employment resources that are interactive, comprehensive, and useful (www.cds.hawaii.edu/employable).

CHAPTER 5. FINDINGS

The four individual case studies presented in this chapter each provide a rich description of the participants and focus on their unique challenges as human beings. The cases also highlight how participants engage with technology with an emphasis on learning via the web. Within each case a basic demographic description of each person is provided along with in depth reporting of how his or her disability is viewed and accommodated to realize full inclusion into society through technology. Data introduced include excerpts from the study interviews and responses to the *EmployAble* project's pre and post surveys. All of the participants needed to self-identify as being a person with a disability in order to participate in the *EmployAble* study and gave a detailed account of types of assistive technology they used, which reaffirmed their usefulness as a model for this study. Per the multiple case study approach, the four participant case studies are presented in the following fashion:

1. First, individually, with a discussion related to demographics, survey data, and interview data;
2. Second, collectively, with an emphasis on similarities and differences among the cases; and,
3. Last, in a separate chapter where overall themes and patterns are discussed.

Participant #1 - Curt

Demographics

Curt is a 56 year-old man living in the Midwestern United States where he has lived most of his life. He was involved in an automobile accident in 2005 that left him with severe traumatic brain injuries (TBI) resulting in a combination of short-term memory loss, limited motor skills but still able to walk unassisted, and a reduced cognitive ability to perform tasks he had done daily before the accident. He underwent 9 months of physical therapy until being able to navigate unassisted and live on his own. Previously he had been an AutoCAD designer for a custom high-end plumbing manufacturer for almost 20 years but upon returning to his position he soon realized he was unable to perform at his previous levels of work and decided to enroll with his state's Vocational Rehabilitation (VR) office to explore alternative professions.

The VR suggested he go back to school and offered to pay his expenses to support his academic pursuits. There was little advising provided to Curt in what his options might be and later in how he could adapt to new employment so he enrolled in the local University and began an unstructured academic program with no plan as to a degree or profession. During the first semester he became acutely aware of the challenges he was confronted with as a student with TBI. In class, lectures were difficult to follow and process. Note-taking was a struggle because of the need to both listen and write comprehensive and logical statements for referencing at a later time. The course syllabi were difficult to understand and offered no assistance with helping Curt to monitor where he was in class or what assignment was due when. He began to fail the in-class quizzes and was reluctant to ask questions in class. As with many students re-entering school, he blamed himself for his inability to keep up with the class (Nilson, 2013) and considered dropping out until one of his instructors suggested he visit the student disability services office for advice on receiving accommodations or assistance with the course work.

Curt was given a screen reader software program to interact with textbooks. The program converted texts to portable document files (PDF) as an electronic alternative to the assigned paper bound required textbooks sold in the bookstore. The screen reader highlighted each word of text thus enabling him to follow the flow of the page and not get distracted. The ability to systematically go through the textbook at his own pace and have a clear reference point of where he was on the page greatly enhanced his memory and retention of the material. The student disability services office requested that Curt be given extra time on his quizzes and tests. Once he was able to take advantage of the screen reader and time allotment, his grades improved and eventually he was admitted to graduate school and completed a master's degree. He credits the one instructor who suggested getting assistance with his ability to finish school and his interest in disability studies, where he found a community of like minded people who shared his interest in how society viewed people like him and what areas of action he could pursue to make life for people with disabilities better.

Once he completed his post-secondary education, Curt became active in the disability advocacy community. He was asked to be on the board of trustees of the local Ability Center where he served on the program and scholarship committees for advancing educational possibilities for people with disabilities. As chair of the accessibility committee of the local county commission on disabilities, he successfully lobbied for greater bus terminal access at a

popular shopping area by having the city move the bus stop so people did not have to cross a busy intersection. He started a state recognized brain injury support group and gives presentations nationally around preventing TBI and giving assistance to people with TBI and their families. Overall, Curt exhibited a high degree of self-awareness regarding his disability and this was reflected in his knowledge of the need for accessible technology though not necessarily in how it was created.

Survey Data

On his pre-survey for the *EmployAble* project, Curt self-identified as a white male between the ages of 40-55 with a graduate degree. He also identified as having an acquired disability (not from birth), listed as traumatic brain injury, uncertainty regarding both an orthopedic and intellectual disability but positive about learning and psychiatric disabilities. He indicated on the survey that he was not currently using assistive technology but that he had advanced computer skills and his resume was posted on an online employment focused website. He wrote that technology skills were not a barrier to his gaining employment but that he was working 10 hours a week or less. He believed his disability was a barrier to working more hours because of co-worker and employer attitudes but not to his ability to perform the given tasks, keep up with the workload, understand expectations, or his social interactions with other people. He also indicated a preference for learning mainstream communication technologies to help with the social interaction aspects of being employed and expressed a desire to use Skype for engaging with the *EmployAble* activities outside of Second Life®.

On completion of the *EmployAble* project, all participants were asked to complete a post-survey to assess how they liked the project and respond to what they did or did not learn as a result of competing the three phases. Curt gave an "excellent" rating for learning new technologies, interacting with new tools and resources, improving on existing technology skills, communicating and networking with others, and he stated in the open-ended section regarding the effectiveness of the mock interview, "Second Life® encouraged me to relax as I participated in mock job interviews" and "made me aware of the fact that prospective job interviewers will ask questions designed to reveal interviewee detriments that will end any possibility of potential employment." He also said, "Second Life® encouraged me to see how I appear to prospective interviewers [and] Second Life® afforded opportunities to engage others." Curt indicated that the information on the Second Life® site was "very accessible."

Interview Data

Curt participated in a first interview in person, where it became apparent for the need to modify the interview questions and adjust the research questions to better reflect a participant's view of how accessible technology was being used. In the first interview, Curt had issues concentrating on the questions even though he had been given the written version beforehand. When asked about his knowledge of the web accessibility guidelines and universal design for learning, he flatly stated he had no knowledge of either topic and the interview became driven and led by the researcher.

The next time Curt was interviewed, the questions were emailed to Curt so he could respond at his own pace and give him time to reflect on the questions. The revised interview questions were structured around the three platforms of the *EmployAble* project: (a) the online self-paced interview module, (b) live video chat group sessions and, (c) the Second Life® virtual learning areas with the recorded job interview practice sessions. Curt stated he "was unfamiliar with the W3C guidelines" and "did not require assistive technology" but had "limited knowledge of accessibility features," "used accessible voice recognition software" and the "accessibility feature I am familiar with is PDF version of textbooks." Although he had mastered the skills to use both the screen reader and voice recognition programs, he preferred using mainstream technologies as he stressed the lack of training with the assistive technologies introduced at the Disability Support Services when he went back to college.

When asked to describe his disability, Curt stated: "On May 17, 2005, an automobile accident caused significant injury to my brain resulting in physical, cognitive, and emotional impairment. Since re-emerging from states of coma and amnesia for 10 weeks, I am driven to recovery as much of my life as possible. What I could not anticipate prior to the accident and recovery is how my experiences of impairment, enhanced expression of my humanity." Curt is unique among the study participants in that he acquired his disability and had experienced life without a disability. He was able to reflect on what it meant to be disabled without it having been a lifelong "given"; he knows what it is like to be a part of the "abled" world and not to be treated as a person with a disability.

When asked about the technology skills introduced to him during the *EmployAble* project, Curt responded: "The *EmployAble* project provided my first experiences of the Second Life® virtual environment and SKYPE (sic). While I've not engaged in Second Life® outside the

EmployAble project, I see its potential to contribute/enhance valuable computer skills. As I've used SKYPE independent of the *EmployAble* project." One of his stated goals of participating in the *EmployAble* project was to learn new communication technologies with the emphasis being on mainstream technologies that others used and not specific assistive technologies such as the screen reader he had been advised to use in school. He went on to explain the employment-focused skills he acquired as, "The ability to effectively use a computer and operate various employment-related programs/softwares (sic) is a vital part of the documentation aspects of my work as a case manager. Yes, the *EmployAble* project's interview preparation module promoted self-confidence, which continues to support my ability to function in the social service organization I serve." When asked about the skills that extended beyond employment, Curt stated: "In my work prior to my traumatic brain injury, and for a brief time after the accident, I worked as an aluminum die cast designer. The job required use of a variety of highly sophisticated computer softwares (sic). Use of the Second Life® virtual environment reinforced computer skills that remained dormant."

The virtual world experience of Second Life® for Curt was unique from the other participants. He found "accessing/using the avatar in Second Life® provided the greatest challenge" but the "Second Life® virtual environment reinforced computer skills that remained dormant" and "manipulating and maneuvering the avatar in the virtual reality site in Second Life® made cognitive demands, and this exertion provided much needed 'exercise' for my brain."

Participant #2 - John

Demographics

John is a 28 year-old male living in a major metropolitan western United States city. He is a person with a visual impairment and benefits from the use of assistive technologies emphasizing audio and tactile communication. Currently he is a college student majoring in information technology with a focus on assistive and accessible technologies. He also volunteers at a local community based organization that assists people with visual impairment to acquire employment based skills. His goal is to work for a technology firm such as Apple, advising about accessibility. At a local government public hearing, he advocated for improving navigation and services at the main train station. John has advanced computer skills and posted his accessibility

reviews of mainstream equipment such as a Mac Pro laptop and Android Nexus 7 phone on an obscure and fledgling social media site that uses audio files instead of text for people to interact. He was referred to the *EmployAble* project through his vocational rehabilitation counselor.

John was unique from the other research project participants as he came to the *EmployAble* project with basic virtual world Second Life® skills. However, he decided not to have the recorded mock interview done in Second Life® like the other participants, but instead opted for practicing his skills using the Skype video chat program which he saw as a better use of mainstream technology he could use to interact with the general online population. The project collaborator in charge of training participants to use the virtual world provided separate sessions for each group with a disability including those with a visual impairment. Trainers utilized the virtual world web browsers, SLtext (Hodge, Collins, & Giordano, 2009) and Radagast (www.radegast.org), which are modified text-to-speech web browsers designed for the visually impaired that incorporate added features such as pre-determined responses to other avatars (e.g., hello my name is, how do you do, etc.) and a "seeing eye" guide option with other avatars to assist with navigating the virtual world. The virtual world platform consists of every object creation being given a text tag or identifier. These tags are what the text-to-speech web browsers recognize and audio output to the user for guidance through the virtual world site. It was interesting that despite this accommodation, given John's focus on learning interview skills and not utilizing the visual aspects of Second Life®, he preferred to use the Skype audio recording for feedback and reinforcement.

Survey Data

On the pre-survey data, John self-identified as a 25-40 year-old male born with a visual impairment who uses a screen reader as assistive technology. John was the only participant out of the four who came with a working knowledge and basic skills for using the virtual world program Second Life®. His resume was posted on more than one social media site and website for employers and he had been unemployed for over 5 years but was attending school in the meantime. His self-identified barriers to employment included job experience, mentoring and peer support, job preparation, and search skills. He indicated that his disability, employer or colleague attitudes, supports or accommodations, technical needs for doing the job, workplace culture, and social interaction were not barriers.

The post survey results indicated that John gave the *EmployAble* project credit for improving his interview skills, communicating with others, and improving technical skills. But he rated the project poorly for not getting him networked to gain employment as one of his goals being to engage more with the mainstream online population. As with the other three participants, he stated an improvement with his Second Life® skills but he did not access the virtual *EmployAble* Second Life® site and resources.

Interview Data

When asked to describe himself, John said: "[I] am trying to get work in the IT space as a Help Desk Support tech to start and eventually hopefully as a QA tester for accessibility. I'm hoping also to work for Apple in some capacity." His hopes for participation in the *EmployAble* project included: "The ability to work at my own pace on interviewing and other employment skills." For technology skills learned during the project, John said he "learned how to watch and interact with online videos in more places and honed screen reader skills that could be helpful in job situations." The technology skills he thought he needed for his own employment advantage included: "Use of screen readers and knowledge of remote access applications, particularly in the IT sector. The *EmployAble* project didn't help with this because that's not what it was about."

Regarding his thoughts on the technology skills intended for employment with benefits beyond just the job, John stated: "Knowledge of operating systems in order to troubleshoot effectively and knowledge of screen readers for personal leisure activities." His own technology skills with assistive technology were high: "I know 4 different screen readers on Windows and also am familiar with IOS and android screen readers. I also use braille displays sometimes" and, "I use JAWS screen reader on Windows and Voiceover on the mac along with voiceover on IOS and a focus 40 blue braille display." He stated his difficulty with certain accessibility features were mainly: "Videos due to the visual nature. Would improve by including audio description where available."

Of the three *EmployAble* phases he found most beneficial, the online self-paced interview module provided the best experience for engaging with the material and learning how to prepare for a job interview, which matched John's main goal for participating in the project. Although the online module included videos, the audio features provided all the needed information for reinforcing the text material. However, he did state that "presentation of materials in multiple text formats such as Braille and Daisy" were preferred as "videos are not that important."

John was aware of the W3C accessibility guidelines and thought the *EmployAble* web content was accessible with his screen readers: "I have very basic knowledge. The web content seemed to fully comply from what I could tell." But he had not heard of UDL, "Not as familiar with that." As for making more content accessible for people, John stated: "Compliance with all web accessibility laws or guidelines that might be developed. Perhaps more ways of taking advantage of touchscreen devices like ipads (sic) to represent concepts in a more tactile way."

Although John had basic virtual world Second Life® skills before joining the project, he opted for the interview practicing on the Skype video chat program. He said that he did not prefer the "Second Life® modules primarily because they weren't standard in terms of navigation and it just didn't feel realistic enough." He did feel the "web content seemed to fully comply" with being accessible and was not a barrier to engaging with the learning material.

Participant #3 - Anna

Demographics

Anna is a 59 year-old female living in the Midwestern United States who became deaf at 2 ½ years old. She was sent to an oral school for the deaf where she learned to lip read and speak but not to use American Sign Language (ASL). Anna considers herself a lifelong learner and earned a doctoral degree at a University for the Deaf where she finally learned ASL. Her connection with others who were deaf expanded with her learning sign language and being immersed in an academic setting. Before she began using assistive technology, Anna was completely dependent on family members for connecting with others and for socialization. Her transportation and communication needs had to be managed by someone else and she had little to no control over time issues or content. She says that phone calls were a major obstacle and required patience that hearing people would not understand. Technology provided a new means of independence and connection with the outside world.

Anna was the first in her family to own a desktop computer, which she purchased while attending graduate school. To engage with television, Anna bought a Sears and Roebuck captioning decoder box to take advantage of the federal regulations requiring closed captioning on publicly transmitted channels (Blatt & Sulzer, 1981; Westinghouse Evaluation Institute, 1979). However, the decoder was not very mobile, only selected shows had captions options and she had to use her own television set for captioning to work. Next she acquired a teletypewriter

(TDD) for telephone calls that required a relay operator to transcribe the conversation into text, a benefit available to the deaf because of federal regulations (Nash & Anedith, 1982). However, her family and friends did not like using the relay operator for the phone calls and getting connected to the service could be troublesome and inconvenient.

When cellular phones became commonplace, Anna wondered why deaf people could not enjoy the same level of communication independence. Fortunately, technology evolved quickly with mainstream Blackberry and iPhones having speech-to-text applications built-in (Rogers, Silverman, Naik, Lenzo, & Rottler, 2010; Silverman, Naik, Bellegarda, & Lenzo, 2013). Video relay phone services with private phone numbers also evolved specifically for deaf users (Brunson, 2010). Mainstream video chat programs with added text feature such as Skype and Facetime provided a common source for Anna to communicate with both deaf and hearing people. The availability of text messaging programs meant that Anna's communication modes blended seamlessly into generally accepted mainstream communication modes. When she did her practice interview for the *EmployAble* project, she was able to use her assistive technology as though it was just another mainstream piece of equipment. With the FCC ruling on closed captioning (Sillman, 1984) making it required on all television broadcasts in the US, Anna could watch her favorite shows anywhere she wanted for the first time. Although she utilized hearing specific assistive technologies such as Sorenson ntouch® (application to call out or receive video calls to communicate with the Deaf), Glide App to send video "texts" to both hearing and Deaf contacts, and Video Phone Service, she primarily took advantage of mainstream devices such as Macintosh Book Pro, Apple iPhone and iPad.

Survey Data

For the pre-survey data, Anna self-identified as a 55+ year old female with a hearing impairment or deafness, living in the Midwestern United States, who uses a video phone with closed captioning for assistive technology. She indicated she had been unemployed for 2-5 years but had been attending graduate school during that time period. She had no background with using virtual world technology such as Second Life® and was highly motivated in working on her job interview skills through the *EmployAble* project. She had a resume but did not have it posted on any social media or job focused website such as LinkedIn but had used online employment focused websites to search for possible opportunities. Anna was not using

vocational rehabilitation or any other service to find a job or seek support for her employment needs.

Anna felt her main obstacle to employment was a lack of experience but that she had the necessary skills and supports to do the work. She did feel employer and colleague attitudes toward her disability and the workplace culture were factors in not getting job offers but not her ability to socially interact with others. She stated her main objective with the *EmployAble* project was to find employment opportunities through networking but was not interested in group meetings preferring an individual mentor.

For the post-survey results, Anna expressed her appreciation to her online mentor for taking the time to focus on her resume concerns and work with her on the practice Second Life® interview where she used a text communication device to interact with the mock employer. She stated she had improved her technology skills, learned desired job seeking skills, posted her improved resume to online employment resources and applied for a job. She was the only participant who actively used the Second Life® resources for information as well as the same resources on the *EmployAble* website and reported it as very useful in learning the new skills and accessing resources. Anna said the Second Life® practice interview was useful because it felt real and she was able to interact with others while practicing her replies to questions in a manner she would use for an actual interview. She also engaged with the most online meetings (5+) with her support group/mentor and gave it the highest rating among the four participants.

Interview Data

In describing herself, Anna stated "Being deaf means that I can and could do anything except hear…and also means overcoming obstacles to communication." She experienced a wide range of measures designed to help her communicate, "During the 70's and early 80's, I depended on lip-reading and classroom notes to earn my high school degree, Bachelor degree, and two Master's degrees...However in the 2000's, I learned ASL during my doctoral program, and felt that I had received more access to communication in the classroom than ever before." She was keenly aware of her dependence on others: "Before accessibility technology became available, as a young adult, I spent a lot of time driving to family and friends' homes to see if they were home for a visit—they were either there or not. I was dependent on family and friends to make phone calls for me, which were not easy feats." And later: "In 1988, I bought a Sears TV captioning decoder box to watch Closed-Captions on selected shows on my stand-alone TV.

However, I was limited to watching those TV captions in my home, but not in another person's home." When she was able to use a Teletypewriter (TDD) to call people on the telephone (typing communications which is then read and spoken through an interpreter) she said, "While I did have access to communication, my friends and families did not like using the relay interpreter and having to dial the relay number first, and connecting (to) me with my own number."

A turning point came around the time communication technology went mobile, "When my family and friends got their cell phones, I was envious, and wondered why the Deaf could not have a more accessible cell phone", however, "since then, technology has evolved so rapidly that I feel so blessed to have more access to communication, such as having the FCC ruling on TV closed-captioning anywhere (at home, friend's home, bars, airports, etc.), ICQ, Blackberry, iPhone, Skype, FaceTime, Glide, texting, video phone services (using my own permanent number), and communication apps on mainstream devices."

The virtual world experience in Second Life® "was a challenge for someone new in using the virtual reality platform. I found that access to Skill Builder, and Access Info were most helpful, and offered by the *EmployAble* project. I particularly liked the Practice Interview in Second Life®, as it made me feel like my interview was conducted live and real. I also enjoyed meeting other participants (avatars) in Second Life®." She said the "challenging aspect of the *EmployAble* project is to learn how to navigate within the virtual environment Second Life® as a platform. This virtual platform was the FIRST and newest technology I had ever come across, and I was thankful to have had a virtual training provided by Development for *Virtual Ability*, Inc., prior to participating in the Pilot Study."

When asked about assistive technology use, Anna responded, "The Sorenson ntouch® App is installed on my Home TV, iPhone, MAC, or iPad to call out or receive video calls to communicate with the Deaf, or to use video relay service to communicate with hearing family, friends or business contacts" and "Glide App to send video texts to both hearing and Deaf contacts." She also gave examples of using mainstream technologies such as "the following video chat forums to communicate with both hearing and Deaf contacts, via lip reading, using ASL, or texting (as in dual video and texting): FaceTime, The Skype, Google Chat."

Anna stated that an important need in terms of accessible technology is that: "Close-captioning need(s) to be available and correct for all videos; i.e.; News, YouTube, Netflix Streamlining movies, webinars, etc., that are provided online. If captioning is provided, they

need to be correct in the use of sentences, grammar, spelling, or content." She went on to detail specifics regarding the difference between subtitles and captions: "Closed-captioning has been available for most American or English-spoken DVD movies; however, foreign movies usually provided English as subtitles for the foreign language being spoken, but not necessarily the Closed-captioning when English is spoken in parts of the movies. I would pause the movie, and ask my hearing parent or friends what was being said during the spoken English dialogues in the movies. That is not fun disruptive process."

Anna gave examples of how captioning technology should be used and where: "Close-captioning needs to be readily available everywhere…especially in transport announcement (bus, Metro, airplanes—especially in-plane movies), and in DVDs, whether they are movies, fitness, educational training." She gave an example of software being developed: "Speech-to-Text would be a great option in the WWW (the exact opposite of Dragon Speaks.) Right now, Transcence (See the video in http://www.transcense.com) is developing an app that will translate speech into written words that show up on a smartphone. That is, a new software is being created to turn a smartphone into a real time speech translator. This is most useful in communicating with others one-on-one, at in-group settings, at meetings, and at seminars. Perhaps, there will be no need to use CART [Communication Access Realtime Translation] in the near future." She even gave an example of an alternative format option, "I would love to have the option of a PDF be readily available to download if the webinar provider would not provide Closed-captioning."

When asked about features that were difficult to use she wrote: "Improper use of colored texts and colored backgrounds in websites or PDF for readability and printing" and "I find that Google Video and Text Chats can be hard to turn on. My hearing friends and I would spend minutes trying to figure out how to invite each other, and answer Google Chat calls. I am not sure how to contact the web administrators to ask them to improve on those features that would be so helpful for all of their consumers." Both of these observations related to accessibility, and usability, features not targeted toward the deaf and reflected on mainstream challenges for engaging with programs and text formatted documents.

Participant #4 - George

Demographics

George is a 31 year-old male with Asperger's Syndrome currently living in the Pacific region of the United States. He earned a bachelor's degree at one of the local private universities while living at home and has actively been searching for employment since graduating. He considers himself to be tech savvy and an advanced computer user but not so with other devices such as tablets. He is active in the disability community as a self-advocate, has spoken in front of audiences, and serves on advisory boards representing himself as a person with an intellectual disability. He participated in an internship focused on inventory control as part of a government sponsored program but was not offered a job once the program ended and still does not know why. He later did some temporary office work but was unable to find steady employment with the assistance of vocational rehabilitation. George is dependent on public transportation that can be time consuming given his home in the suburbs and distance from the main city center where most of the jobs he applied for are located.

George's main challenge is socializing with other people and following generally accepted social protocols within groups to which he is not well acquainted. He is aware that people may not feel completely at ease with him and works to correct others perception of people with intellectual disabilities through his volunteer work with advisory boards and being a self-advocate. Upon joining the *EmployAble* project as a participant, George expressed his desire to interact with people either through the virtual world experience or preferably, in person. He worked at introducing himself with a handshake and making eye contact, even though this was beyond his comfort zone. He quickly learned how to navigate in the virtual world of Second Life® and participated in one of the group activities of selecting clothing for the mock job interview. He engaged with the others by providing feedback about the best job attire based on the online module of interview appearances. When the opportunity arose to meet with other *EmployAble* participants in person, George took the two hour public transportation ride and arrived early. He spoke about his experience with the Second Life® clothing gathering.

His in-person *EmployAble* project group meeting with other participants, all whom had a disability including the group leader, resulted in raising his employment expectations. Upon listening to his intern experience, the group leader questioned him on why he had not pursued the same type of employment. George responded he had reservations as the internship had not

resulted in permanent employment and he viewed this as an unsatisfactory job performance indicator. George was encouraged to emphasize the internship experience on his resume and apply for related positions. Within a month, he got a job doing onsite inventory control.

Survey Data

For the pre-survey, George self identified as a 25-40 year old male born with Asperger's Syndrome living in the United States Pacific Ocean region, with an earned bachelor degree. He rated his computer skills as moderate, stated he did not use any assistive technology and had no virtual reality Second Life® skills. Unlike the other research participants, George reported never having gone through a job interview but had posted his resume on an employment focused online job board and signed up for a social media employment focused site. He reported not using any employment support services such as vocational rehabilitation and that his main barriers to employment were job readiness, the need for peer or mentor support, and disclosing his disability to potential employers, but not people's attitudes toward his disability. However, he did state he had challenges with identifying a good job fit, workplace culture and socialization, and understanding job specific expectations and requirements. He wrote his personal goals for participating in the *EmployAble* project were: "I want to find a rewarding work experience to utilize my skills of cooperating well with others, being detail oriented and being consistent in my work ethic."

The post-survey data showed what George thought of his experience with the *EmployAble* project as positive: "This project allowed me to experience an interview for the first time. I usually got my jobs without interviews." He rated as "excellent" his interaction with the online tools and resources and development and refinement of his technical skills. Making new contacts and learning "things I did not know" were marked as important aspects of his experience. Even though he felt more confident in his ability to find a job, he did not feel more confident regarding his ability to retain employment. When asked to give two examples of how the *EmployAble* project online material helped or did not help him, he wrote: "I was able to prepare for an interview and I learned how to work with others better."

Interview Data

When asked to describe himself, George responded: "I'm going to be very young but also very wise, somewhat learned, and I can make eye contact pretty easily and keep it for a while." Participants were given the option of writing their answers to the interview questions or doing

the interview live on a video chat program such as Skype or Google Hangouts. George was the only participant to choose the live option but was given the interview questions beforehand much like the method used for the mock job interviews used in the *EmployAble* project. When asked to elaborate on the question focusing on self description, George stated he had nothing to add about himself but continued on the eye contact theme. Interviewer: "When you say you can make eye contact, how long do you usually keep eye contact?" George: "It varies on the subject, okay? It usually varies on the subject based on what I'm doing." He then asked to move on to question two but the interviewer asked: "Do you try to avoid situations, make eye contact or is that not a big deal?" George: "Sometimes I try to avoid eye contact, but when I do make eye contact, I can be interested in something for a while." Interviewer: "Okay." George: "Number two, if you're ready?"

The second interview question concerned what most interested George about participating in the *EmployAble* project. He responded: "I have never used the Second Life® technology before and that's what really interested me." Interviewer: "Was it primarily learning about the technology?" George: "Yes. As far as outcome?" Interviewer: "Yeah." George: "I wasn't expecting to end up with a job per se, but to meet others and learn about the technology and maybe get some pointers in the right direction." Interviewer: "So, the primary one is learning about the technology. The second one was like maybe getting a job. Was that pointers for getting employment?" George: "Yeah. Pointers for eventually getting employment because I eventually expect to get a job out of this project, per se." Interviewer: "Okay. What ended up happening? Did you end up getting a job?" George: "I am currently supposed to be working with an inventory service for stores, but I haven't received any assignments recently." Interview: "Okay. But, you did initially get something, right?" George: "Yeah."

The next question focused on technology skills learned during his participation in the *EmployAble* project and why these skills were important. George responded: "I was able to handle live video chat and being able to figure out how I should handle myself in an interview better. I think these are important because sometimes people do have the opportunity to do video calls and such, and that could be interesting." Interviewer: "One of the big things you liked learning about is how to do the video chat?" George: "Yeah, and being able to do better job interviews." Interviewer: "You do think it helped you with doing job interviews?" George: "Yes." When asked as a follow-up if he did the real job interviews with the video chat, George

stated his real interviews were in person but the practicing online helped prepare him. Interviewer: “Did you do job interviews in person or did you do them through the video chat?” George: “In person.” Interviewer: “In person. So, was it the practice?” George: “Yeah, right.” Interviewer: “What about the practice? Was it seeing the recording of you or was it having somebody there giving you feedback right away?” George: “Feedback.” Interviewer: “The feedback. You thought that was the benefit of it?” George: “Uh-huh.”

However, when asked if he continued to use the video chat and Second Life® skills, George responded: “I have not used video chat too much. I haven't been using the Second Life® too much,” but followed up with, “but video chatting can extend beyond employment.” Interviewer: “Tell me about it. What do you think?” George: “I think it can be useful to reconnect people throughout the world, those who need to reconnect.” He stated he was working on using Skype to connect to a relative in Minnesota and was in the processing of teaching her how to use it. He recognized the mainstream use of communication technology such as the video chat program Skype, as beneficial to connecting with people. When asked which of the *EmployAble* online programs he would continue to use, he answered the self-paced Interview module because, “It's a possibility to use again. You can always practice by yourself for the interview.” However, when asked which program was the most useful, George stated: “I think the most useful for me was the live video chat.” and which was the most difficult, “I would say most challenging was Second Life® because I've never really been acquainted with it before.”

When asked about assistive and accessible technology, George demonstrated a high level of awareness although he said he did not need either because, “I don't know too much about accessibility for technology because I don't have any physical disability.” When asked who benefited from these technologies, George stated, “Yeah, maybe blind, maybe deaf, other things like that.” He expressed a high degree of confidence with his technology skill level, “I can use technology pretty well,” and when asked about his mainstream assistive technology use, he said “Voice text, I haven't used that too much, but it can be useful. I just don't need to dictate too much.” Interviewer: “Got it. You are familiar with our programs that you can talk and then it writes it out on the screen? George: “I'm familiar with those but I don't use it that much.”

George was aware of Universal Design for Learning (UDL) principles. Interviewer: “Have you ever heard of universal design for learning? Are you familiar with that concept?” George: “Yes, I think it was effective. I think this project was effective in applying those

principles." He followed up with, "Almost everyone who was available to use the project was able to use the project in a way that they felt comfortable with." He went on to state: "Yes, it was beneficial. I may have needed some additional refresher and that's why I saw the material more than once." Interviewer: "Okay. So you thought it was beneficial? That's a universal design principle of learning (principle), so showing it again and again, having it repeat in different places in different context was good for you? Is that what you're saying?" George: "Yeah."

As a person with a disability George demonstrated an awareness of others with similar challenges and this was more apparent when interacting with the *EmployAble* project online modules. He said, "I'm talking about in the online stuff, the interview module?" Interviewer: "Okay." George: "Seeing a variety of people. Understanding that this could happen to almost anybody." Interviewer: "You thought that was helpful?" George: "Yeah." Interviewer: "So, the fact that you saw other people going through the same sort of things that you were going to go through, you saw that as a benefit?" George: "Yes." Interviewer: "You saw that on the online module or in Second Life®? Which one did you stick out more to?" George: "The online module." Interviewer: "The videos that were on there, just seeing that somebody else is doing the same thing, really you saw that as a benefit?" George: "Yes." The relating to others with disabilities through the module videos and Second Life® engagements translated into increased self-confidence for George: "I was a bit more confident. I knew that I might have to face this, so I figured if other people are doing it, I'll just get into the material." Interviewer: "When you went out and actually did a real job interview, did these things help you, too? Did that boost your confidence in going in there?" George: "Yeah." Interviewer: "Before you went into the Employable project, how confident were you going in to do a job interview?" George: "Not that confident." Interviewer: "So, going through the Employable thing really boost your confidence on it?" George: "Yeah." This awareness and self-confidence extended to the group meetings. Interviewer: "In the group meetings. During the group meetings you found it beneficial to see how other people were dealing with it, struggling, however you want to put it?" George: "Yeah."

When asked about his own struggles and suggestions for improving the *EmployAble* project learning activities, George stated: "I didn't have too many challenges, but as far as improvements, I would maybe...I thought that maybe slowing down would not be a bad thing if a person needed to." Interviewer: "Okay." George: "In order to be able to eventually move on to where they needed to be." Interviewer: "Did you think it was just too fast paced?" George: "No,

it was the right pace for me." When asked to give an example George said: "I think it was at one of our meetings." Interviewer: "Okay." George: "I sensed they were...Maybe they didn't grasp it as well as I did." Interviewer: "Yeah. When you were in the group setting and you were basically, like everybody does, you were comparing yourself to the other people who were there, and you felt like you were better able to do it, is that what you're saying?" George: "Yeah, I thought I was better able to do it, but maybe I was wrong."

When asked how accessibility and technology could be improved in general, George deviated from the other three participants. Interviewer: "What do you think is needed in the future? Do you think there ought to be more laws, better software, better design to make online learning platforms such as *EmployAble* accessible and useful? What do you think needs to be done just in general?" George: "Software is probably something we can do better on, education of others and designing of applications that can be used by a variety of people." Interviewer: "You don't see that adding extra laws is not going to change much?" George: "Sometimes it makes it worse." When asked to elaborate, George said, "As for application, I let other people figure that kind of thing out because I'm not exactly who they're targeting." Interviewer: "Right. Okay. I see what you're saying. You feel pretty comfortable with the existing technology? You can pretty much get on it and use it? There's no big barrier to you getting on and using it? Is that what you're saying?" George: "Yes. Not many barriers for me."

Participant Similarities and Differences

Although the four participants identified as people with disabilities, there were characteristics that joined and separated them as representatives of their specific group. The following highlights the similarities and differences through the context of this study and how it affects accessibility for technology for each disability category and individual.

Similar to all the participants were their understanding that accessibility for people with disabilities was available and more important, necessary for many people to engage web-based content. Ironically, none of them had a clear understanding nor knowledge of how this process worked. The fact that there were laws surrounding the issue of accessibility was known but not how technology and content could be made accessible. There was a vague to non-existent recognition of the W3C or UDL. The two participants who expressed some knowledge, the deaf participant Ann and the autistic George, had a low knowledge base of UDL but not enough to

articulate this knowledge to a potential employer or educational administrator. The differences were more apparent and provided insight into how the issue of education could be addressed.

All four participants recognized the benefits of using mainstream technologies to connect with others whether for socialization or employment. Although disability specific communication programs and support groups were available to each participant, they all expressed the preference for the mainstream programs available online and popular with non-disabled people. The advent of accessible features being built in to readily available technologies such as smart phones, gave the participants an element of hope that their individual communication needs would be met by future technology advances. Such items as text-chat, voice recognition, and even spell check, demonstrated the integration of accessibility into the mainstream domain.

Another area of agreement was the need for better training and education of accessibility issues to the general population. Curt stated his preference for mainstream technologies stemmed from the lack of training on his screen reader program from the Disability Support Office at his university. He had to learn it himself because the support staff had very little knowledge of how to use the program to best fit his needs. John's career goal was to work as a computer support technician and eventually as an accessibility technology reviewer. Anna expressed her desire for closed captioning in publically displayed information areas such as train stations and airports, technology already in use but confined to select media such as television and cinema. George was more direct in stating better education regarding accessibility as needed for everyone.

The differences between the participants were reflected around who were born with their disability; George, Anna, and John, all had a better awareness of what they needed to use technology. Screen readers for John, text-based communication devices and captioning for Anna, and although George did not "need" assistive or accessible technology, he was cognitive that somehow he benefited from advances in mainstream technology. Curt, who had acquired his disability, struggled with using assistive technologies as a routine process and had mixed experiences with accepting he may need it. He, unlike the others, never fully realized the benefits, though he knew that assistive and accessible technologies could possibly help him, he felt sure there were others who were benefiting. Curt was the only participant who had challenges with the Second Life® virtual reality experience but persisted in using it for his recorded practice job interview.

CHAPTER 6. DISCUSSION & CONCLUSIONS

The central question of this research study was how people who rely on accessible technology to engage digital content, whether on the web or through a variety of output devices, actually make use of materials developed using guidelines intended for their benefit. First, the findings showed a high degree of awareness by end users for implementing the two sets of guidelines, the W3C Web Content Accessibility Guidelines and Universal Design for Learning principles. In particular, users highlighted the need for alternative formats and multiple means of representing the same material. Second, end users demonstrated an increased sense of self-confidence through learning and becoming competent on technologies, and benefited both from being able to use accessible technology and from being able to transfer their knowledge to more mainstream technologies.

One major theme with two sub-themes and another major theme with three sub-themes emerged through the process of data coding, data analysis, and validation of the coding for this project. The following major themes and subthemes emerged:

1. Multiple means of representation;
    a. Universal Design for Learning;
    b. Accessible technology awareness;
2. Technology confidence building.
    a. Application of mainstream technology;
    b. Overcoming barriers to the use of technology;
    c. Confidence building beyond technology.

This section will explore these themes, their links to the conceptual framework of Diffusion of Innovations' reinvention process, and implications of the analysis for answering the research questions:

1. How did users with disabilities perceive the integration of accessibility in online multi-platform environments designed based on the following contemporary standards:
    a. Current accessibility guidelines including the World Wide Web (W3C) standards?
    b. Universal Design for Learning (UDL) principles?

2. What is the perceived impact on users with disabilities of the integration of accessibility into online multi-platform learning environments?

Implications in Context of Research Questions

Providing the same material in different but accessible formats for assistive and mainstream technologies creates a welcoming atmosphere and lets students remain anonymous without having to identify themselves to the instructor or other students that they may require something "more" to engage with the course material and complete the class. Research question one asked how users perceive accessibility into online multi-platform learning environments and the multiple means of representation theme provided a good fit for addressing the issue and opening up a dialog for further discussion.

Subcontext research question 1(a) emerged as how should accessibility guidelines be adopted in online multi-platform learning environments, providing a direct link to research question one in that the W3C guidelines create the formula for accessible content and give software and hardware manufacturers standards to comply for a seamless digital content transition to multi-platform output devices (i.e., smartphones, tablets, and Wi-Fi connected game consoles).

Subcontext research question 1(b) emerged as how should Universal Design should be applied to multi-user platform learning environments, providing the frame for a direct reference to UDL's first principle of multi-means of representation. It should be noted that creating alternative formats, or multiple-means of accessing formats, needs to be done by providing the exact same material and not by giving supplemental but substantially different formats. This is important if the learner is to be expected to demonstrate the same knowledge being taught. Providing an additional learning element without it providing the needed contextual and specific knowledge for learning what is required does not fulfill the first principle of multi-means of representation.

Research question two, regarding the perceived impact on users with disabilities of the integration of accessibility into online multi-platform learning environments provided a good fit with the technology confidence building theme in that the availability of accessible content and mainstream programs with multi-featured communication options give people with disabilities the opportunity to be included without having to rely on assistive technology specific programs

to engage and interact with others online. Furthermore, having an increased sense of confidence to fully utilize their technology options and find a best fit for the circumstance under which they are engaging (virtual world platform, group online meeting, or learning management system) provides users with disabilities an equal footing for postsecondary education and employment opportunities in an increasingly technology driven world.

Theme 1: Multiple Means of Representation

Brief Description of Theme

Multiple means of representation is the leveraging of learning material. This process includes providing multiple file formats and application options such as video or text files. As discussed in the literature review (Hitchcock & Meo, 2001; Myhill et al., 2007; Opitz, Savi, Savenye, & Rowland, 2008), the Universal Design for Learning principles are used in creating an accessible learning experience beyond the need for using assistive technology to interact with learning content. The repeated display and multiple formats of content for learning gives participants the opportunity to engage and interact with the learning material at their own pace and with their device of choice. The one size fits all approach did not find a dedicated following among the four participants of this research project. That participants preferred multiple tools and formats fits with previous research on learner perceptions of distributed learning environments (Dede, Whitehouse, & Brown-L'Bahy, 2002; Menchaca & Bekele; 2008; Cowan & Menchaca, 2014). When asked what he liked about the online materials being repeated across the three online platforms George responded, "Yes, it was beneficial. I may have needed some additional refresher and that's why I saw the material more than once", and "Almost everyone who was available to use the project was able to use the project in a way that they felt comfortable with". Anna said: "I found the (a) online self-paced interview module and (b) live video chat sessions to be most useful because those are the most VISUAL common components or platforms that I am most familiar with", and "Instructions were provided in both orally and in writing to engage students auditorily and visually", and, "allowing us alternative ways to act skillfully and demonstrate what we know through Second Life® virtual chat rooms, SKYPE (sic), and emails."

Subtheme 1: Universal Design for Learning

Directly linked to the theme of multiple means of representation was UDL. Three of the participants expressed little knowledge on the topic of Universal Design but elaborated on the

advantages of its theoretical foundations when describing what they preferred for learning content in the context of the *EmployAble* project curriculum. Anna presented a detailed explanation of the UDL principles and also expressed how she preferred having the option of multiple materials and devices, whether it was assistive or mainstream technology and stated: "variety of methods were used to present information, and provide a range of means to support," and, "There were cooperative learning opportunities for individual, pair, and group work as well as distance learning, peer learning, and fieldwork through the Second Life® virtual chat rooms, SKYPE (sic), and emails."

Subtheme 2: Accessibility Technology Awareness

Having content available on demand requires that it be formatted with accessibility features and W3C guideline requirement for output device independence. This is especially important for assistive device users such as those mentioned by John, "I use JAWS screen reader on Windows and Voiceover on the mac along with voiceover on IOS and a focus 40 blue Braille display." He stated his difficulty with certain accessibility features: "Videos due to the visual nature. Would improve by including audio description where available." Anna, who relies on the accessible technology option of text captioned videos, stated: "Close-captioning need(s) to be available and correct for all videos; i.e., News, YouTube, Netflix Streamlining movies, webinars, etc., that are provided online. If captioning is provided, they need to be correct in the use of sentences, grammar, spelling, or content." Both Curt and George reported being aware of accessible technology use by people with disabilities, with Curt explaining he "did not require assistive technology" but had "limited knowledge of accessibility features," "used accessible voice recognition software," and "accessibility feature[s] I am familiar with is PDF version of textbooks." George stated: "I don't know too much about accessibility for technology because I don't have any physical disability," and when asked in follow-up who benefited from these technologies, George stated: "Yeah, maybe blind, maybe deaf, other things like that."

Conceptual Framework Link

The DOI framework focusing on the fourth phase of implementation and the process of re-inventing the technology being diffused offered a good fit with the multiple means of representation theme by highlighting the combination of the W3C guidelines for web content accessibility and the Universal Design for Learning principle of multiple means of representation used to present the learning content of the project. From the literature review a similar

proposition was expressed but not applied (Burgstahler, Corrigan, & McCarter, 2004; Judge & Floyd, 2011). What is more important is why one method is not strictly chosen over the other. The implementation of the W3C guidelines seems to be straightforward with a checklist readily available for use and a history of being recognized as the primary source for technical accessibility for the web. Applying the guidelines for accessible websites and content has not been documented as an easy process as shown in the literature with the study of 100 US Federal Government sites (Olalere & Lazar, 2011), higher education institutions (Barrett, 2011; Coombs, 2015; Sutton, 2016), and online learning courses in particular (Lorenzetti, 2013; Myhill et al., 2007). This would validate three of Rogers' (2011) eight reasons for why individuals or organizations do not adapt the original concept in its entirety as follows: (a) Difficult to understand, (b) General in concept with many possible applications, and (c) Used to solve a wide range of problems.

Theme 2: Technology Confidence Building

Brief Description of Theme

The ability to use technology in an effective and rewarding manner may apply to everyone but is an even more important need for people who are dependent on technology to interact and engage with others. All four of the participants expressed their desire to learn more about using technologies in the *EmployAble* project for purposes beyond getting employment. From online networking to communicating online with family and friends, all four stated they had learned something from the project besides how to prepare for a job interview. Given that each participant had their own set of challenges and perceived barriers to engaging with others online, they highly valued the ability to use and realize the online world of communication.

Subtheme 1: Mainstream Technology Use Adaptation

All four participants demonstrated a preference for using mainstream technology when given the option. Being able to use programs that offer text, audio, and video provides alternatives for people who may have a greater dependency on one of the features over the others. The ability to use programs widely accessed by the general public made for an inclusive experience and was expressed as being important through the interviews and surveys.

Subtheme 2: Technology Challenge Barrier

Although having challenges with technology is a common human experience, people with disabilities encounter difficulties directly related to their disability whether physical, sensory or intellectual. Overcoming technology barriers as a sense of accomplishment was a common theme among all four of the participants.

Subtheme 3: Confidence Building

A common desired outcome among the participants was learning new technologies offered in the *EmployAble* project curriculum, which included the virtual world Second Life® experience with avatars and mainstream online communication programs such as Skype and Blackboard Collaborate. The pre and post survey data confirmed that participants gained an increased knowledge of online technologies while participating in the project and had a level of satisfaction demonstrating increased confidence in being able to use the technologies for seeking employment opportunities and online socialization. Although all four participants rated themselves as being proficient with using Second Life® after the project ended, none of them indicated any use of the program past *EmployAble* and the only participant with any prior experience with Second Life® ended up asking to practice his interview on Skype. During the interviews, all four stated an increased confidence in using both assistive technologies they already used and mainstream online communication programs such as Skype.

Conceptual Framework Link

The second theme to come out of the coding was unexpected and did not fit with the re-invention aspect of DOI. Building confidence through technology use was a result of the end users being able to access the technology but did not involve the selection or use of the accessibility guidelines. This is an intriguing finding, and merits further research and discussion within the context of learning design and technology.

Overall Implications and Conclusions

To summarize this research project, the following issues are providing a concise and final set of conclusions linked to the research questions. The themes developed from the four participant interviews were integrated with Roger's DOI, with an emphasis on the implementation process and how it fit with the review of the literature. Challenges with DOI and people with disabilities interacting with technology as expressed in the literature was reviewed

along with how the participants' experience measured up to the other research data in the field of accessible and assistive technology. Next, recommendations on issues related to DOI and how it can be addressed are outlined along with topics identified in the literature. What was learned and just as importantly, what was not learned is addressed and recommendations for further research highlighted. Finally, an overall recommendation for how systems can be improved for better implementation of accessibility was addressed as a conclusion to this research project.

DOI Implementation Implication

The eight main reasons Rogers gives for re-invention or modified adaption of an innovation (i.e., accessibility via the web) is discussed in the context of the four research interviewees and findings from the literature review.

First, accessibility guidelines as presented by the W3C Web Accessibility Initiative are difficult to understand. As shown in the literature (Sutton 2016; Ellison 2004; Farr et al. 2009; Lazar et al. 2013), accessibility standards are difficult to enforce and it is challenging trying to place responsibility for implementation. Requirements provided to web developers and increasingly web content providers, are generalized regulations, such as Section 508, and highly specific instructions for creating accessible platforms and content without a direct link between the two (Burks 2013). The outcome or needed benefit for the end user of accessible technology is not well illustrated or understated even for the user. This was evident in this study as three of the participants demonstrated a lack of knowledge in articulating how accessible technology should be applied. The fourth participant who was deaf could explain the requirement for captioned and audio described videos but not how the technology for the other end users, such as visually impaired or cognitively challenged people needed to be implemented. Although they were aware of the accessibility guidelines to varying degrees, none demonstrated the ability to articulate how a web developer or content provider should use the guidelines to benefit an end user. Universal design and UDL are often cited as supplementary or alternative means of providing accessible technology delivery with a concentration on multiple means of engagement (Burgstahler 2011). Sometimes the literature also references the W3C/WAI guidelines (level 2, etc.) suggesting the same strategy for compliance with disability regulations. There is a major focus point on compliance with specific regulations while overlooking other strategies for dealing with multiple disability challenges. For example, designers might focus on content accessible to a screen

reader without addressing font size or contrast issues that would assist a larger population of the visually impaired audience.

Second, a lack of detailed knowledge about accessible technology is prevalent among decision makers in creating accessible technology and web accessibility policies (Lorenzetti 2013; Matausch et al. 2012; Moreno et al. 2011). Although the W3C/WAI guidelines (Youngblood 2013; Miñón et al. 2014) are written by web developers and provide detailed and updated information for use by other web practitioners, there are no legal or widely used curriculum for training and no nationally recognized certification programs. Anyone can become a web designer and they are not required to be knowledgeable about accessibility.

Third, the range of people who rely on accessible technology varies to a wide degree, from the visually impaired to deaf or cognitively disabled people. The W3C mission statement includes other populations who can benefit from accessible technology such as older adults with age related impairments, English as a second language learners, and people with temporary disabilities. The concepts of accessibility are relatively straightforward, such as screen reader usable, linear navigation, or the use of captioned videos, with their use applicable to many situations requiring technology either on a standalone device (i.e., computer table in a classroom) or a live worldwide webinar presentation. All four research participants mentioned the benefits of accessible technologies beyond the confines of the *EmployAble* project and their social use for communicating with others.

Fourth, providing information and instruction via the web gives institutions such as schools, a way to solve physical access challenges for people with disabilities and be compliant with disability access regulations such as the Americans with Disabilities Act (www.disability.gov/resource/disability-govs-guide-disability-rights-laws). Although offering online courses and providing institutional public information has benefitted the general public, it has made the need for accessible technology and compliance more imperative for people depending on accessible platforms and content.

Fifth, the "pseudo-reinvention in a cosmetic way for localized ownership" or giving an innovation a new brand to claim ownership without providing any meaningful re-invention, has developed from the formation of associations focusing on disabilities. Many disability specific organizations segment the accessibility guidelines for the benefit of their represented end-user population. Examples include the American Foundation of the Blind (www.afb.org/info/living-

with-vision-loss/using-technology/12), the National Association of the Deaf (https://nad.org/issues/technology/television-and-closed-captioning), the Brain Injury Association (www.biausa.org), and Autism Speaks (www.autismspeaks.org/family-services/technology).

Sixth, decentralized diffusion systems may require end-users to innovate without a structured plan. All interview participants indicated they were self-taught in their use of technology and this was reflected in the lack of knowledge of accessibility guidelines and others' use of accessible technology.

Seventh, innovation that is altered to match the structure of the organization requiring the adaptation did not provide a good fit with the research study findings. Accessibility guidelines and UDL are primarily targeted towards individual web applications and end-users who use other aspects of the organization such as instruction or training with the web as a platform to distribute information or content.

Eighth, to address late adoption benefiting from early adopter's learning curve, the last reason for re-invention or adaptation of an innovation such as accessible ready web content provides a compelling view of the question of how accessibility is being realized. The research participants all expressed a readiness to use new technologies to achieve their objectives of communicating through the web regardless of little or no knowledge whether or not the technology was Section 508 compliant. John, the blind user, and Anna, the deaf participant, both were experienced users of assistive technology and expressed how accessibility had improved along with technology that is readily available to the public. This would indicate a possible link to accessibility laws requiring companies developing and selling new technologies to be compliant with Section 508. Both John and Anna stated they used non-specific assistive technologies to engage the web and how it made the engagement an easier process. George, the participant with autism "who didn't need assistive technology," expressed his desire to use consumer oriented video chat programs to communicate with his aunt. As cited in the literature (Burgstahler 2009; Burgstahler 2011) regarding universal design for learning, having multiple means of engagement is a guiding principle for enabling people with disabilities and those without, to interact and engage with others for communication and learning. The trend of web-based communication platforms to include video, text, and audio for users provides the opportunity for those requiring one of these alternatives, a direct method to participate without

having to ask for assistance with using a specific assistive program. This would also provide a good fit with Roger's innovation gatekeeping with web communication companies offering these alternative communication modes as a standard in their publicly available programs. Accessibility statements from companies such as Apple's Facetime (www.apple.com/accessibility), Google Hangouts and Duo (www.google.com/accessibility), Microsoft's Skype (https://support.skype.com/en/faq/.../what-accessibility-features-are-available-for-skype), Facebook Messenger (www.facebook.com/accessibility), Instructure Canvas LMS (www.canvaslms.com/accessibility), and Blackboard (www.blackboard.com/accessibility), provide a combination of the W3C guidelines and UDL's multiple means of engagement.

Diffusion of Innovation and People with Disabilities

Roger's DOI as a framework for acceptance of accessible technology is well grounded in people with disabilities being able to use mainstream communication with others who may not require an alternative mode to interact. The notion that re-invention of an innovation, in this case, the application of accessible technology, is frequently perceived as a criticism of the pro-innovation bias of DOI with the researcher taking their own point of view as "rational" and "appropriate" without consulting the end-user's perception (p. 114) is well demonstrated in the literature (Sapp, 2007; Oud, 2011; González, Moreno, & Martínez, 2012; Matausch, Peböck, & Pühretmair, 2012; Miñón, Moreno, Martínez, & Abascal, 2014). Also, focusing on a limited target audience for research on a singular aspect of engagement such as access to web browsers for blind users (Ferreira, da Silveira, Capra, & Ferreira, 2012; González, Moreno, & Martínez, 2012) and evaluating how well the W3C guidelines fit for the same target group is prevalent in the literature (Babu & Singh, 2013). However, this overlooks the fact that accessible technology is in itself an innovation with widespread applications to varied audiences and how adoption requires research being done at many different levels and situations. One size does not fit all, as Roger (p. 114-5) states, "Re-invention is an important way in which an innovation is changed to fit the adopting unit's situation." He goes on further to recognize that the "why" questions about adoption are seldom effectively studied by diffusion researchers because the motivations for adoption are difficult to investigate.

DOI Framework Challenges

Implementing a workable and sustainable accessibility policy for all three parts of the innovation process including policy makers, web designers and content providers, and lastly,

web users needing the accessible platforms and content, is the key challenge of technology acceptance as outlined by the DOI framework. As stated previously, the first three DOI stages (knowledge, persuasion, and decision) are well documented in the literature and by the data collected from four participants of this research study. Farr (2009), Jaeger (2009), Farrelly (2011), Capra (2012), Ferreira (2012), and Miñón (2014) demonstrated that private business, educational institutions and government relied on federal legislation for persuasion of decision making regarding accessibility, while concluding that implementing these guidelines were problematic. While the four participants in this research study stated a knowledge, although limited, of the need for technical accessibility and were aware of the laws and regulations surrounding accessibility, the complexity of implementing those guidelines were vague to them.

DOI Identified Recommendations

The need to re-invent accessibility guidelines for implementation presents a challenge in need of clarification into simpler and useable terms. The eight reasons for re-invention as previously discussed showed how complex the issue is and why this phase of DOI demonstrates where the fundamental issues should be addressed.

Literature Review Issues Recommendations

Issues as identified in the literature review can be categorized into three areas: (a) Need to link accessible outcome to specific group needs, (b) Need of end users in research and, (c) Need for enforcement of existing accessibility laws. Each of these present a unique challenge for web practitioners if Tim Berners-Lee's goal of an accessible web for all can be realized, but all are required to make it happen. Without enforcement, entities have little motivation beyond catering to the needs of a specific group to make their websites and content accessible to people who rely on the implementation of accessibility guidelines to engage the web. No monitoring of problems encountered by end users are publicly available as with other analytic applications used for gathering information about web users demographics. Although the US and other countries have accessibility laws, these almost always require a class action lawsuit to bring about recognition of a problem usually resulting in a quick fix with limited long-term oversight (Bühler et al. 2011; Goldberg 2013; Groves 2011). Accessibility features are not always linked with to whom and why they are beneficial. The W3C/WAI guidelines and publicly available accessibility checkers such as WebAIM's WAVE (http://wave.webaim.org/) provide excellent links to the intended outcomes (i.e., structured headings assist screen readers in navigating) but a

follow-up as to the frequency or level of importance is not provided for web practitioners to help rationalize the need to other important decision makers for implementation of an accessible feature. This leads to the final problem of a lack of end-users, who actually may use assistive technology and rely on accessible technology, as part of the research on evaluating the effectiveness of intended accessibility features. Designing learning platforms with meaningful content and outcomes requires that all learners, including those with disabilities, be included in the formative and summative evaluation of the building process. One of the findings of this research project, identified in both the surveys and interviews, was that the participants were unaware of what was needed to make their individual web experience more accessible although they were very aware of accessibility laws and the need to have accessibility built into the programs and content they were using.

Future Research Recommendations (Research)

The three areas recommended for further research are

1. establishing evidence of the link between accessibility guidelines and practice outcomes as experienced by end users,
2. establishing evidence of the links between accessibility and understandable and useable regulations and,
3. establishing appropriate design methodologies that consider accessibility when developing mainstream technologies.

This research study did not discover how specific guidelines, whether from the W3C or UDL, provided the necessary outcome of accessibility to the end user. Guidelines currently are ineffective in part because they are described as suggestions and not requirements, especially the more rigorous and higher the level of guideline. This is problematic as many people relying on accessible technology have multiple disabilities or combinations of challenges such as age related or socio-economic (i.e., lack of access to high speed internet access and cutting edge technology), and this is a barrier to identifying the best set of features to use. Other issues include regulations and laws regarding technical accessibility; enforcement and terminology could be better defined for effective outcomes. Since most, if not all, international and domestic regulations are based on the W3C and UDL (to a lesser degree), the links between these guidelines and regulations need to be better defined and clarified to assist web practitioners with implementing and justifying the need for accessibility features to their stakeholders.

Guidelines for Practice Research. To provide a better understanding of why the guidelines need to be used, more research into how people with disabilities and others who benefit from accessible technology needs to done. The context of the research should address not only specific disabilities or challenges but also include the numerous combinations of disabilities and challenges.

Guidelines for Regulation Research. To provide web practitioners with a developed and understandable set of tools to promote accessibility laws, more research into the links between the guidelines and regulatory outcomes, needs to be done. Although generalized regulations provide space to accommodate new technologies, clearer definitions would give regulators a more direct method of enforcement.

Guidelines for Design Methodologies. To provide accessible ready technologies and web-based programs that do not require retrofitting for people who use assistive technologies or benefit from the established accessibility guidelines, better integration of accessibility needs into established web design courses and degrees or certificates, would forward progress for seamless accessibility. Making the knowledge of accessibility guidelines a requirement for professional certification would streamline the process for a smoother transition of people with disabilities into using mainstream technologies.

Overall Recommendation (Practice)

In conclusion, the findings of this research study lead to the following recommendations for implementing a more inclusive online community where people who use assistive and accessible technologies can engage and interact through web-based communication platforms and equally participate in socially relevant activities such as education:

1. Integrate researched-based accessible technology factors for specific disability focused groups into regulations for all publicly available web-based activities,
2. Integrate accessibility training into web practitioner training via institutional certification and,
3. Provide publicly available online demonstrations of research to practice showing the advantages of accessible technologies to the general public through accreditation reliant institutions (education, insurance, government, legal, etc.).

Requiring an early exposure to a wide range of professionals on the benefits of an inclusive web will result in considerations for requiring accessible standards at the beginning of a

web-based endeavor as opposed to the current situation of retrofitting existing platforms to conform with non-understood guidelines. The process will not happen rapidly but once implemented and commonplace with web practitioners and users, Tim Berners-Lee's goal of a universally available web for all will be realized.

Table 3. Summary of Research Objectives and Conclusions

Research Questions	Findings (Themes)	Conclusions	Recommendations
1. How did users with disabilities perceive the integration of accessibility in online multi-platform environments designed based on the following standards:			
How are the World Wide Web Consortium Guidelines used?	Multiple Means of Representation Subtheme: UDL Subtheme: Accessibility Tech Awareness	Create alternative formats addressing visual, sound, navigation and cognitive issues based on W3C/WAI guidelines	Organize guidelines into the four distinct alternative categories: visual, hearing, navigation and cognitive, Enforce accessibility regulations for online learning through institutional accreditation
How is Universal Design applied to multi-user platform learning environments?	Multiple Means of Representation Subtheme: UDL	Multiple accessible formats of original material	Alternative formats based on four categories: visual, hearing, navigation and cognitive
2. What is the perceived impact on users with disabilities of the integration of accessibility into online multi-platform learning environments?	Technology Confidence Building	Adaptable technology options with accessible formats	Provide mainstream tech options for all users

The purpose of this research study was to evaluate how and why accessibility guidelines are used to assist people with disabilities engaged in online learning. The research questions were developed based on the researcher's experience as the media coordinator at the Center on Disability Studies at the University of Hawaii and as Project Director of the *EmployAble* project, which used three distinctive learning platforms to train people with disabilities to prepare for a job interview. The study used a multiple case study methodology, along with previously collected survey data, to explore questions related to the design and impact of a multiple platform online learning environment. The findings, based on case studies of four participants, showed a strong preference on the part of participants for the availability of a variety of accessible materials and the choice to both access and choose between mainstream platforms when engaging the learning material. Also, the four participants showed a strong motivation to try new technologies with the desired outcome of being included in the general population through mainstream technology use. Implications of the study include the need to (a) enforce existing legislation around access to technology, (b) develop competencies and accreditation requirements related to accessibility of online courses, (c) simplify and segment existing online accessibility guidelines so that they are easier to implement and, (d) conduct research on the real-life applications of web accessibility protocols and Universal Design principles to ensure that the intentions of these guidelines match actual desired outcomes.

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APPENDIX A

Interview Questions

1. Tell me a little bit about yourself. What would you like me to know about yourself that will help me understand you as a person?
2. What interested you about the *EmployAble* Project? What were your expectations as an outcome?
3. What important technology skills did you gain from participating in *EmployAble*? Why do you think these are important?
   a. (prompt if not answered above) What technologies do you believe are important for obtaining and retaining employment? Did the *EmployAble* project offer these skills?
   b. (prompt if not answered above) Which employment technology skills extend beyond employment and why?
4. Which of the three components of the *EmployAble* project: a. online self-paced interview module, b. live video chat sessions, or c. virtual reality site in Second Life, did you think were the most useful for you and why?
5. What were the most challenging aspect(s) of the *EmployAble* Project for you and why?
6. Tell me about your knowledge in the area of accessibility for technology?
   a. (prompt if not answered above) Tell me about the your knowledge of the W3C guidelines? (if applicable) How effectively do you think the *EmployAble* Project applied these guidelines?
   b. (prompt if not answered above) Tell me about your knowledge of Universal Design for Learning? How effectively do you think the *EmployAble* Project applied these principles?
7. What assistive technologies, such as screen readers, voice-to-text programs (Dragon Speaks), input devices besides a mouse or keyboard do you use?
8. What accessibility features, such as multiple representation of material, are important to you to make the online learning environment accessible? Which features are not important to you?

9. Which accessibility features are difficult for you to use? How would you improve these feature(s)?

10. What do you think is needed in the future (prompt if needed laws, software, education, design applications) to make online learning platforms such as *EmployAble* accessible and useful?

APPENDIX B

Dissertation Code to Theme Development

Initial Codes
Code: Assistive Tech Use
Code: AT Knowledge
Code: AT Awareness
Code: Disability Needs
Code: Technology Barriers
Code: Disability Awareness
Code: Social Interaction
Code: Accessibility Standards Awareness
Code: Institution Accommodation
Code: Universal Design Principle

Inter rater code suggestions July 19th 2016

Codes
Mainstream tech use
Knowledge of Assistive Technology
Use of Assistive Technology
Confidence building
VR Learning Challenge
Self Understanding
Existing Tech Skill Enhancement
Self-Paced Curriculum
Use of SL beyond Project
Disability Specific Challenges
What's Not Important for Access
Direction/Feedback

New Codes
Disability Awareness
    Sub-Code: Internal
    Sub-Code: External
Mainstream Tech Use (Adaptation)
Accessibility Technology
    Subcode: Awareness
    Subcode: Use

Assistive Technology
    Subcode: Awareness
    Subcode: Use
Universal Design for Learning Application
Confidence Building
Technology Challenge/Barrier

	DK	MR	SB	MU
Assistive Tech Use	5	6	2	3
AT Knowledge	5	6	1	5
AT Awareness	4	2	2	0
Disability Needs	4	3	1	3
Technology Barriers	1	2	2	3
Disability Awareness	3	1	1	5
Social Interaction	2	2	2	13
Accessibility Standards Awareness	2	2	4	1
Institution Accommodation	1	0	2	0
Universal Design Principle	1	2	1	3

2nd Code Development

	DK	MR	SB	MU
Access Tech Aware	3	2	13	4

	DK	MR	SB	MU
Access Tech Use	2	5	6	2
Assist Tech Aware	1	1	2	1
Assist Tech Use	1	10	6	0
Confidence Building	5	3	6	15
Disability Aware Internal	3	1	15	8
Disability Aware External	0	0	12	10
Mainstream Tech Use Adapt	1	2	8	9
Tech Challenge Barrier	3	3	12	7
UDL	3	5	12	5

2nd Cycle Code Set

Theme: Multiple Means of Representation

- UDL
- Access Tech Awareness

Theme: Tech Confidence Building

- Mainstream Tech Use Adaptation
- Tech Challenge Barrier
- Confidence Building